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WATER CONSERVATION IN THE TWIN CITIES METROPOLITAN AREA

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ABOUT THIS REPORT

This report is Working Paper No. 5 in a series of eight. The reports are being prepared as background technical studies for the preparation of a long-term water supply plan for the Metropolitan Area. The long-term plan preparation was required by the 1989 legislature and must be presented to the legislature on February 1, 1992. Preparation of the long-term plan follows completion of a short-term plan, which was delivered to the legislature on February 1, 1990.

The other technical reports in the series are:

- No. 1 Alternative Sources of Water for the Twin Cities Metropolitan Area. Metropolitan Council Report No. 590-91-011.
- No. 2 Water Demand in the Twin Cities Metropolitan Area. Council Report No. 590-91-009.
- No. 3 Water Availability in the Twin Cities Metropolitan Area: The Water Balance. Council Report No. 590-91-008.
- No. 4 The Public Water Supply System: Inventory and the Possibility of Subregional Interconnection. Council Report No. 590-91-010.
- No. 6 The Effects of Low Flow on Water Quality in the Metropolitan Area. Council Report No. 590-91-054.
- No. 7 The Economic Value of Water. Council Report No. 590-91-065.
- No. 8 The Institutional Framework for Water Supply Management. Council Report No. 590-91-064.

The report was prepared by Florence Myslajek and Judith Hartsoe of the Metropolitan Council Natural Resources and Parks Division. Questions on the content of the study can be directed to Florence at (612) 291-6520 or Judy at (612) 291-6323. Data on water conservation efforts of local units of government in the Twin Cities Metropolitan Area were drawn from a survey of suppliers done by the Metropolitan Council. Graphics were prepared by Craig Skone.

WATER CONSERVATION IN THE TWIN CITIES METROPOLITAN AREA

INTRODUCTION

Water conservation in the Twin Cities Metropolitan Area is defined in this report as "any beneficial reduction in water use or in water losses". Two types of water conservation are described: long-term conservation and short-term water use reductions. Water conservation practices by water suppliers can be classified under two types:

> Supply management, in which the supplier conserves water by altering practices within its own system; and
>
> Demand management, in which users must cooperate with the supplier in reducing the use of water.

Examples of supply management include metering, leak detection and repair programs, pressure reduction and watershed management. Demand management programs include metering, pricing programs, regulations and education.

Conservation practices can also be used by those commercial/industrial establishments and private individuals who supply themselves. System efficiency improvements and demand management within the home can reduce water use within these demand sectors.

To date there is no overall, coordinated plan for water conservation in the Twin Cities Metropolitan Area. There are a number of federal, state and local agencies (that is, suppliers) that have the potential to impact water conservation.

In Minnesota, the Department of Natural Resources (DNR) is the state agency with the greatest authority over water use. The commissioner of the DNR is charged with developing a water resources conservation program for the state and for carrying it out through its appropriations and permitting program. The Minnesota Pollution Control Agency (MPCA) and the Minnesota Department of Health (MDH) are responsible for maintaining good water quality. The MDH has the authority to revise the plumbing code to encourage wise use of water with water saving devices.

One of the responsibilities of the Environmental Quality Board (EQB) is to coordinate comprehensive, long-range state water resources planning. The EQB updated a previous plan and adopted it as the Minnesota Water Plan in November 1990. The Minnesota Board of Water and Soil Resources (BWSR) provides a forum for discussion of local water and soil resources management issues and resolution of statutory water policy conflicts.

Much of the basic responsibility for water conservation is left to local agencies . Although water supply planning can go on at all levels of government, the agency supplying the water has the

prime responsibility. Metropolitan Area counties can prepare ground water plans. Surface water management plans are prepared by Watershed Management Organizations (WMO) and have to be consistent with county plans in the ground water component.

Other opportunities for water conservation occur in the commercial/industrial sector and wastewater treatment process. Contingency plans also need to be in place for short-term water shortages caused by drought or contamination of the water supply.

Although general public opinion usually favors water conservation, there are some barriers to implementation of specific programs.

> The perception still lingers that water supplies in the Twin Cities Metropolitan Area are unlimited.
>
> There is some reluctance to make any changes in well-run existing systems that serve their communities well.
>
> Revenues from sales of water have financed improvements for local units of government.
>
> Short-term costs for water conservation programs must be absorbed before any savings are realized.
>
> Regulations on water use may present some adverse effects as well as advantages.

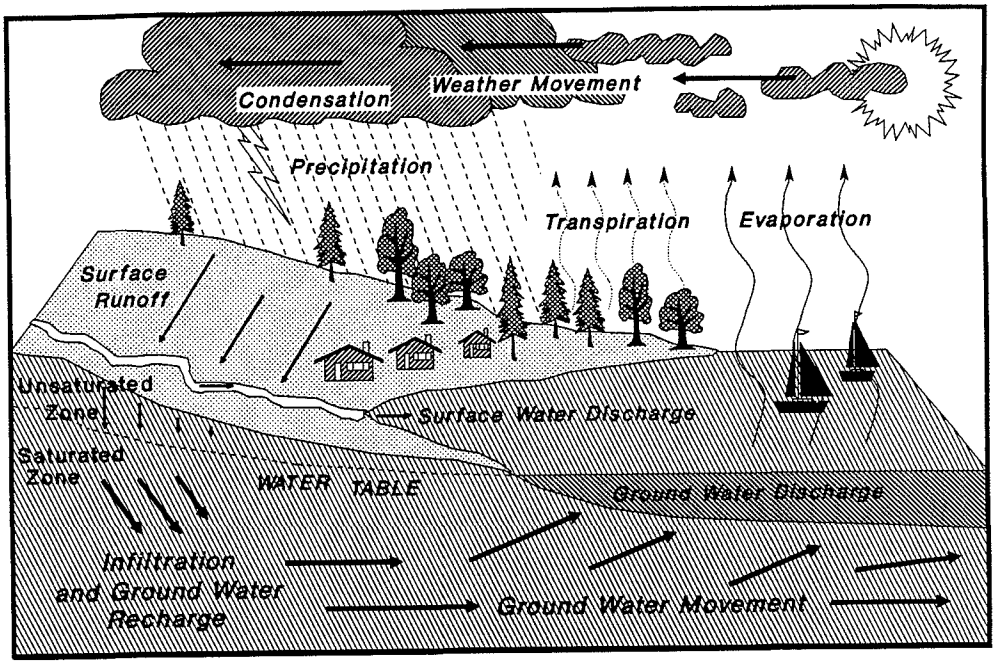
Water conservation plans are an efficient way to respond to water shortages. Water conservation is beginning to be looked upon as an alternative to new source development. In the past, it was considered necessary to have regional planning only for surface water. With growing demand for water projected for the Twin Cities Metropolitan Area, regional planning for ground water may also be necessary. This issue will be addressed in the long-term water supply plan being developed by the Metropolitan Council for the Metropolitan Area.

BACKGROUND

Fresh water is essential to life, not only for human beings but for other life forms, as well as for their shared food supply. While water covers 80% of the earth's surface, only 1% of this water is fresh and clean enough for drinking, cooking, and bathing. Water also serves as an important base for recreational activities. According to the old saying, "You never miss the water until the well runs dry", planning is needed now to ensure that the wells do not run dry and that we have an adequate supply for future needs in this Metropolitan Area. Water conservation is one means of extending our supply. There are good reasons for this viewpoint.

All the water there is on our planet earth today is all the water there ever was or will be. The hydrologic cycle in Figure 1 illustrates the use and reuse of water. The energy of the sun lifts some 500,000 cubic kilometers (about 264 billion gallons) of water from the earth's surface each year. About 86 percent of this is from the oceans and 14 percent from the land. An equal amount of precipitation falls back to earth as rain, sleet or snow. Although 71,500 cubic

Figure 1
SIMPLIFIED HYDROLOGIC CYCLE



kilometers of this precipitation was evaporated from land, about 110,300 cubic kilometers falls back on the land (excluding Greenland and Antarctica). In effect, this solar-powered cycle distills and transfers an additional 38,800 cubic kilometers of water from the oceans to the land. Most of the water then makes its way back to the oceans as runoff and the cycle repeats itself. In this sense, fresh water is a renewable resource.[1]

Under existing climatic conditions, approximately the same total volume of water is available each year worldwide. However, it is not equally distributed. Some areas of the planet have abundant supplies. Others are not so fortunate. Distribution also varies from year to year, as evidenced by our recent drought.

Historically, the Twin Cities Metropolitan Area has been favored with abundant supplies. As related in Water Availability in the Twin Cities Metropolitan Area: The Water Balance, Working Paper No. 3[2], part of the development of the Metropolitan Council's Long-Term Water Supply Plan, the availability of clean, cheap water has been a key factor in sustaining growth and a high quality of life in this area. It is one reason the region has become one of the major industrial centers in the Upper Midwest. Even in the recent past, supplies were seen as endless, an infinite resource. If more water was needed, new wells were dug or new water intakes developed in surface waters. Although this attitude still underlies some water supply actions, a more realistic viewpoint is emerging. This is reflected in Water Availability in the Twin Cities Metropolitan Area: The Water Balance[3].

TOTAL WATER USE IN THE TWIN CITIES METROPOLITAN AREA

In 1988, 75 percent of the total water use (from the public supply) in the Metro Area came from surface water, and 25 percent from ground water. Looking at consumptive use, 94 percent of the ground water was consumed and only 6 percent of the surface water. In other words, much of the surface water was only temporarily withdrawn.

Water use is the withdrawal of water from a supply. This may be temporary or permanent.[4] Table 1 summarizes the 1988 water use in the Twin Cities Metropolitan Area.

Table 1
1988 WATER USE IN THE TWIN CITIES METROPOLITAN AREA

TYPE OF USE	USE IN MGD
Residential	190
Commercial/Industrial	167
Private Works	1
Irrigation	6
Power Generation	707
Sewage Treatment	8
Water Level Maintenance	23
Miscellaneous Uses	1
Total Use in municipally-supplied area	1103
Total Use non-municipally supplied area	13
GRAND TOTAL	1116 MGD

Source: Metropolitan Council. Water Demand in the Twin Cities Metropolitan Area; Working Paper No. 2. Summary Report. May 1991.[5]

Notes: Air conditioning use is included in Commercial/ Industrial. The water level maintenance entry includes lake level maintenance, as well as sand and gravel quarry dewatering. The miscellaneous category includes uses for temporary construction, landscaping, hatcheries, snow-making and pollution confinement.

All of this water is not consumed. Some is used and returned. For example, although power generation uses 707 million gallons per day (MGD) of water, only about 7 MGD is consumed. The remainder is returned to one of the three rivers from which it was withdrawn.

DEFINITION OF WATER CONSERVATION

Conservation may be defined as "the preservation from loss, waste or harm."[6] In this report, water conservation will be used as it was in a previous Council publication, as "any beneficial reduction in water use or in water losses."[7] As understood in this context it is a resource management tool, a method that encourages wise use of the water resource and discourages waste. Conservation

means using water efficiently and avoiding waste, while not unnecessarily curtailing use.[8] The techniques for doing this run the gamut from complex capital-intensive systems designed for recirculation of cooling water to simple changes in individual habits, such as turning off the water while brushing one's teeth.

Two types of water conservation are examined later in this report:

1. Long-term conservation, and
2. Short-term water use reductions to cope with shortages or contamination.

WHY CONSERVE?

Although the Metropolitan Area has long been regarded as a "water-rich" area, there are good reasons to consider conservation as a long-term management practice. Most years there is excess water, and it flows out of the area, but there are problems in distribution within the area. Drought years as recently as 1988 pose special problems. In times of drought it is important to have contingency plans in place, so that priority uses can be met with minimum disruption to normal activities.

Benefits of water conservation include:

1. Preservation of the resource to ensure that good water resources will be available in the future.

2. Elimination or postponement of new source development with associated savings on capital investment, operating costs, and energy.

3. Improvement of water supply efficiency to maximize the use of the resource.

4. Institutionalization of conservation practices that help utilities cope with short-term water shortage emergencies.

5. Reduction of the need for wastewater treatment facility expansions.

PRINCIPLES AND PRACTICES IN WATER CONSERVATION

(Note: Although drawn from other sources as well, the following outline is based, in large part, on a handbook prepared by the New England River Basins Commission, Before the Well Runs Dry.)[9]

In order to be an effective and efficient means of solving water supply problems, water conservation plans need to be part of a coordinated strategy for managing a water supply system. All programs in water conservation need to be carefully evaluated. It is important to consider all impacts of the plan, natural resource, social, political and economic. Certain factors affect the choice of plans, such as the nature of the problem, the need for a utility to conserve, and whether

the need to conserve is a short-term or long-term problem. The amount of reduction that needs to be achieved is another factor that affects choice of plans.

Water conservation programs can be classified under two types:

> Supply Management, in which the utility conserves water by altering practices within its own system and under its control without involving users.
>
> These programs are simpler to implement provided the utility has enough funds and labor inputs to carry out the program chosen. The programs, once identified, will be seen as part of good management.
>
> Demand Management, in which users must cooperate with the utility in reducing the use of water. Users must be convinced that reductions in water use are necessary, or a mandate to conserve must be issued by the supplier. Most users need to be given an incentive to conserve.

Step One in choosing a program is to identify the problems and their source. Is the problem one of inadequate supply occasioned by use exceeding supply; drought; contamination of supply sources; inadequate storage or pipe capacity; or excessive user demand?

Some of these problems have been encountered in the Metropolitan Area. St. Louis Park and New Brighton experienced shortages in the past because of contamination of supply. The drought of 1988 created shortages in several communities. Inadequate storage is a problem that faces Minneapolis and many rapidly growing suburbs. As the cost of energy increases and wells go deeper, energy costs will be a larger factor in the costs of supplying water.

The supply may be inadequate only during the summer at peak use times as demand grows greatly for non-essential uses, such as lawn sprinkling. The supply may be inadequate for only a short term, yet it might require extensive capital solutions, such as new wells or reservoir storage.

Step Two in developing a water conservation plan is to assess the potential for solving the problem with supply management techniques. They may be preferable to demand management techniques because they can reduce water losses and waste without depending on the behavior of users. They make good sense because they improve the efficiency of the system itself. Often operating costs can be reduced. It leaves open the possibility of introducing demand management programs, if necessary, to meet emergency or changed circumstances. The kind of savings achieved with supply management programs depends in part on the age and condition of the water system. If maintenance needs have been neglected in the past, there are more opportunities for substantial savings. A system with a regular program of system improvement and replacement may not achieve great savings with the most common supply management programs, since they are already using them.

The disadvantages of using supply management programs are that some programs are expensive; they are usually labor intensive; and usually there is a long lead time before implementation is possible.

Demand management programs are very versatile and can be implemented quickly. In addition, many of them are inexpensive and do not require a lot of labor. The disadvantages of demand management are that revenues may drop, if based on metered water sales; the success rate varies depending on users' cooperation; and positive results tend to diminish over time.

Step Three in selecting a management program is to analyze the cost-effectiveness and impacts of the various management programs on the individual community and its water supply system.

Supply Management Programs

Common Types

1. Metering can be used to accurately measure and account for all water used. By itself, metering does not save any water. However, it can be used in supply management programs as well as in certain demand management programs. In supply management, metering provides essential information on where and when water is being used throughout the system. The cost of installing, testing, repairing, replacing meters must be calculated. However, metering is needed to provide basic information used for many other water conservation programs.

   Only five communities in the Metropolitan Area served by water utilities lack a metering system. Information obtained from metering systems is used for billing. It is not always used to develop water conservation programs, but it can be a helpful tool.

2. Leak detection and repair programs take the information provided by metering and use it to analyze the difference between uses recorded by metering and total use. If there is a relatively large difference, the community needs to identify the sources of unaccounted-for water. Some losses are known, such as hydrant water used in fighting fires or flooding ice rinks. Other sources may include inaccurately metered water, leaking meters, illegal hook-ups and leaks in water mains.

   Actions taken to correct these problems depend on the nature of the source. Some will be easier and less expensive than others. A leaking fire hydrant can be replaced at a minimal cost, whereas replacing long sections of old water mains may be an expensive proposition.

   After gathering information, the community may decide that the water loss is not sufficient to support the costs of a long range program. On the other hand, some communities have saved substantial sums of money. In 1978 the Boston Water and Sewer Commission saved 255 million gallons of water and $61,200 at a cost of $4,300 through leak detection and repair programs. Even more important than the net savings to some communities is the savings in water, when supplies are limited in the short- or long-term.[10]

   In the Council's survey of municipal water supplies, a number of Metropolitan Area communities listed leak detection and repair as one of their water conservation techniques. However, in many cases, the comment was included that leak detection and

repair was done "as needed." To be used as a supply management technique, leak detection and repair must be done on a regular, repeated basis, not just when a leak is discovered or reported from another source. Further information on leak detection is included in the Council's report on the municipal water supply system.[11]

3. Pressure reduction reduces waste of water by reducing the amount of water passing through the pipes. It is not usually used as a water conservation measure unless the existing pressure is 80 pounds per square inch (psi) or greater. Except in a limited number of applications, it does not have a great potential for water conservation.

   The few communities in the Metropolitan Area who reported using pressure reduction on the Council survey were using it not for water conservation but for balancing their system where different zones had different pressures and as a fail-safe device to protect residences from higher pressures in larger lines.

4. Watershed management, also considered a supply management option, protects water supplies against contamination and over-pumping and can be used to maintain or increase water recharge flows to the source.

   Specific techniques include zoning and subdivision regulations to prevent inappropriate land uses in the watershed as well as purchase of the land in the recharge area. Although of benefit to the water utility, these last techniques often occur without utility input. Good watershed management should be carried out even if water supplies are not short, because it protects the water supply.[12]

Demand Management Programs

If, after analyzing the advantages, disadvantages and projected effectiveness of supply management programs, the water utility managers decide that more needs to be done to meet the conservation goals, demand management programs can be examined. Demand management programs are versatile and can be implemented quickly. Many of them are inexpensive and do not require a lot of labor on the part of the utility. However, decreasing demand may decrease revenues, if users are billed on a metered water basis, and if a conservation or seasonal pricing scheme is not used. The success rate of these programs varies a good deal, depending on the cooperation of users. Going into a program, the level of cooperation is often difficult to predict. Then, too, positive results tend to diminish over time, as we would expect to see after the bad advice issued in 1988 to let grass go "dormant". The experience showed that much grass died in 1988 because of the drought, so people will be reluctant to again limit their sprinkling on the advice of so-called lawn experts.

Some of the most frequently used demand management programs are considered below:

1. Metering can be used in demand management as well as supply management. Knowing they are going to be charged according to the volume of water used may motivate some customers to use less water and avoid waste. This may be effective for high volume users, or if the rates are high. If rates tend to be low--if water is a bargain as in the Twin Cities

Metropolitan Area at an average price of $1.15 per 1,000 gallons--then metering will probably not achieve much saving in water. Mandatory metering should be legislatively pursued, however, since it may result in some savings, if only in the short term.

2. A pricing program, if properly designed, should collect sufficient revenues to cover costs and also encourage water conservation. To reflect the "true cost" of water, the pricing scheme can balance the marginal cost of providing water with the price charged the user.[13] Another paper in this series, Working Paper No. 7, will examine more closely the economic costs of water. Working Paper No. 4 contains details of the water rates charged by each municipal supplier.

   In the past, water has been cheap and plentiful in the Metropolitan Area. The cost to produce and deliver water has been relatively low. Therefore, it has been more difficult to use pricing as an incentive to conserve. Working Paper No. 4 also found that suppliers do not charge enough for water, even under pricing schemes that supposedly lead to conservation.

Table 2
PRICING RATE SYSTEMS IN THE TWIN CITIES METROPOLITAN AREA

Rate Form or Charge	Description
Increasing block	Price per unit of water increases with the amount purchased. Example: first 10,000 gallons is $.80/1,000 gallons; next 1,000 gallons is $.95, etc. Requires meters to measure. Large volume users consider this inequitable.
Single Block	Price per unit of water is constant regardless of the amount consumed. Requires meters to measure. Large volume users consider this equitable.
Decreasing Block	Price per unit of water decreases with the amount purchased. Example: First 10,000 gallons is $.69/1,000 gallons;10,000-30,000 gallons is $.53/1,000 gallons. Requires meters to measure. Large volume users prefer this structure.
Flat Rate	Price is fixed no matter how much water is consumed. Used in very small systems or where the utility has no meters. Does not favor conservation.

A number of other charges can be added to these rates:

- A service charge for the privilege of purchasing water;
- A minimum demand charge, which is a flat charge for a certain volume of water no matter how much is used, up to the volume specified. This initial charge

incorporates a service charge. For example a minimum demand charge for 1,000 gallons may be $5.00. If more water is used, additional charges are made. This is not favored by low volume users.

- A minimum charge is sometimes used without the service charge being included, that is, a minimum charge will be imposed no matter how much water is used.

Table A-1, in the appendix, lists the communities in the Twin Cities Metropolitan Area by water-pricing methods. Flat rate was used by water suppliers in only five communities. Slightly less than half the communities (49%) used a single block. Forty percent used the decreasing block. Less than seven percent used an increasing block. Several communities that use the increasing block approach charge so little that the effect of the increasing price is negligible. Working Paper No. 2, Water Demand in the Twin Cities Metropolitan Area, compared per capita water use by price rate to determine the effects, if any of the four different pricing rate systems on overall water use. As reported in the paper:

> No correlations were evident for the declining block, flat rate or single block rate pricing structures. A slight relationship was apparent with the increasing block structure. [But since only seven cities used this system], it was not significant. . . The mean per capita water use by price rate ranged from 35,000 gallons per year (gpy) to 40,000 gpy.[14]
>
> With more than 89 percent of the communities using either single block or decreasing block, it is apparent that pricing structure is not being used to reduce water usage. Pricing is a cost-effective program that should be considered in any conservation program.

3. Regulations (issuing restrictions on the use of water) can be used to achieve water conservation goals. Users are required by law to comply with the restrictions. Regulations may be short-term, long-term, or take various forms, such as restricting a specific water use like car washing, or:

   A. Supplementing lake levels--During the drought of the late 1980s, the Department of Natural Resources (DNR) was inundated with applications for new permits for wells to raise the levels of specific lakes. In the spring of 1990 the DNR adopted a position that this was not a good use for ground water, especially in a time of scarcity. No new permits were issued and existing permits were suspended. This position was strongly backed by the legislature.[15] (Pumping for Snail Lake in Ramsey County was allowed to continue until Dec. 31, 1990.)

   B. Restricting the time during which specific uses are allowed is also an option, such as restricting lawn sprinkling to odd/even days or certain hours of the day or night. The odd/even regulation does not usually reduce total demand, but spreads it out, which may reduce peak demand. Often peak demand is the greatest problem for communities in the Metropolitan Area during hot summer weather. Sprinkling only at night may reduce total demand because reduced evaporation makes watering more efficient.

The city of Eagan has used sprinkling restrictions since 1987, but began a program of permanent sprinkling restriction in June of 1990. Restrictions are in effect year-round. It is an odd/even ban and applies only to lawn sprinkling. New sod and landscaping are exempt for an initial period. Water demand was decreased by 226 million gallons in 1989 and another 200 million gallons in 1990. The city believes a large share of this reduction can be attributed to their sprinkling restrictions. Public acceptance has been good. Residents have written to the city saying they believe the city is doing the right thing. Violators of the ban have also been reported. The city will renew its notice to water users this year as a reminder.

C. Allowing specific uses such as pool filling or any other use of large volumes of water by permit only. This may be difficult to administer and enforce.

D. Restricting the total quantity of water which can be used seems most appropriate for short term crisis situations. In 1991, faced with the fourth year of drought, some water utilities in the San Francisco Bay area sent notices to homeowners documenting the total water use for the same home in 1987. Residents are expected to reduce water usage by a certain percentage. If they do not comply, penalties will be assessed.

F. Requiring the installation of water saving appliances or fixtures in new or remodeled buildings is another option.

In 1990 the legislature amended Minn. Stat. 326.37 to provide that, "By January 1, 1993, all new floor-mounted water closets in areas under jurisdiction of the state plumbing code may not have a flush volume of more than 1.6 gallons." (Minn. Stat. 326.37, subd. 2) The seven metro area counties and nine others in the state are covered by the Uniform State Building Code, which references the Minnesota Plumbing Code. In the remaining counties of the state, the code still applies to all public and multi-family buildings. If they choose to enforce a code, a community must adopt the same Uniform State Building Code. "Uniform" means that there is a provision in the state building code that no community can adopt provisions more stringent. The Minnesota Plumbing Code is contained in rules and regulations of the MDH chapter 4715.

A provision of the Model Energy Code adopted by Minnesota affects plumbing installations in the same 16 counties. The code requires that all new showerheads installed, or remodeled, must restrict flow to three gallon per minute (gpm).

Regulations can be very effective in saving water. Before adopting specific regulations, the community should consider the cost of administration and enforcement, and the means by which enforcement will be carried out. If regulations succeed in reducing water use, and revenues are based on actual use, the community must be prepared to raise rates or subsidize the program. In the last analysis, the success of regulation will depend, in large part, upon community acceptance.

4. Education is a voluntary demand program that informs users of the need to conserve and enlists their cooperation. It emphasizes that conservation will help solve a community problem and that users will save money.

Education programs are usually well received by the community and they can be especially effective during a water crisis in reducing total water demand or peak demand. The costs of the program vary depending on the means of education and the size of the community. It is often desirable to use education combined with one or more of the other supply or demand management programs.

It may be that in some respects, the general public is more ready for conservation programs than some government agencies realize. Government may have to "catch up" with the public perception of what needs to be done in the area of water conservation.

Many of the water suppliers reported using public education to conserve water in their responses to the Metropolitan Council survey done in 1990. The survey included questions relating to conservation practices as well as general system background questions. Survey responses were received for 109 out of the 111 municipally-supplied cities and townships. More details on this survey are reported in Working Paper No. 2, Water Demand in the Twin Cities Metropolitan Area. [16]

Replies to questions about water conservation efforts are summarized in Table A-2 in the appendix. These programs can take a variety of forms. Some communities have distributed "tip sheets" with water bills or city newsletters listing actions individuals can do to save water, for example:

- Repairing leaks in pipes or fixtures;
- Changing personal habits such as turning off the water while brushing your teeth (saves five gallons); taking showers rather than baths; installing a low-flow toilet or a showerhead with a flow restricter;
- Using less water for outdoor yards and gardens or using more efficient methods, such as a drip irrigation system for gardens;
- Using grasses and plants that require less water; and
- Washing a car with a bucket and sponge rather than the garden hose, or using a faucet with a shut off valve.

These are just a few of the commonly suggested means of saving water that an education campaign can suggest. The major disadvantages to education programs are that the results are not always reliable because of the voluntary nature of the program. The program must also be repeated frequently, or many users may go back to their older, earlier habits, especially if the education program was invoked in a crisis situation.

Installation of water saving devices on a voluntary basis is another form of education. Some communities have distributed water saving devices to all or part of the community.

One such kit contained a low-flow showerhead, a toilet tank dam and a faucet aerator. In most of these programs, the resident was asked to install them. In some pilot programs, usually covering only a portion of the community, city workers installed the devices with the consent of the resident. This type of program would require advance public education to gain acceptance.

The City of White Bear Lake has used public education and requests for voluntary reduction to reduce demand for water. The city has encouraged residents to install water-saving toilets and low-flow showers on both new and existing housing.

White Bear Lake does not currently use sprinkling bans. During dry seasons, the mayor made announcements on television and in the newspaper asking people to conserve water, especially for lawn sprinkling. The response was very positive. The city noticed a drop in consumption. In White Bear Lake requests for voluntary reduction have been more effective than mandatory sprinkling bans used previously. The city projects the need for another well in 1995. The well itself may cost between $250,000 to $300,000.[17]

Another education program has been directed to encourage people to landscape outdoor areas with plants, trees, shrubs and grasses that require less water. One program called Xeriscaping, a trade-marked name, is promoted by a non-profit public service education organization, the National Xeriscape Council, Inc.[18] It is based on seven basic principles:

- Planning and design
- Soil analysis
- Efficient irrigation
- Practical turf areas
- Appropriate plant selection
- Use of mulches
- Appropriate maintenance

This program, and others like it, have been used more often in arid and semi-arid regions of the country where the need has been more obvious, but a few programs in other areas have promoted the same principles and attempt to educate the public in the advantages.

EVALUATING SUPPLY AND DEMAND MANAGEMENT PROGRAMS

To be effective, supply or demand management programs must be analyzed before and after adoption. Although the benefits of water conservation may be easily detailed, there may be adverse effects as well. Some communities have failed to adopt water conservation programs because they did not see any way to finance the initial costs, even though the long-term effects would have been positive. All factors need to be considered, for example:

- How much water and money can the program save?
- How can the costs of implementing the program be retrieved?
- What goals can be achieved? Can the search for new sources be eliminated, or can drilling of another well be postponed?
- What is the level of political and community acceptance of the new program?
- If water usage is reduced to a substantial degree, will this affect the sewer system? If so, how can the system compensate for this reduction?
- If water rates are raised, what effect will this have on existing or potential large volume water users?

Table 3 lists the average amounts of water used for various household activities. From the table, it is easy to see how a substantial water savings can be accomplished through demand reduction strategies.

Table 3
WATER USE STATISTICS

Water User	Water Used
standard shower head	5-10 gallons per minute, 50-80 gallons for 10 minute shower
low-flow shower head	1½-3 gallons per minute, 15 gallons for a 10 minute shower
bathtub	50 gallons
toilet flushing	3-7 gallons per flush
ultra-low volume toilet	1.6 gallons per flush
dishwasher	15-25 gallons
washing machine	35-70 gallons per load
slow dripping faucet	350 or more gallons per month
fast leaking faucet	2000 or more gallons per month
household faucet	3-5 gallons per minute
silent leak in toilet	40 gallons per day
running toilet	5 gallons per minute
washing and rinsing dishes with tap running	5 gallons per minute
washing and rinsing dishes in filled sink	5-10 gallons
garbage disposal	3-5 gallons per minute
standard sprinkler	½-4 gallons per minute
one drip irrigation emitter	¼-2 gallons per hour
½ inch diameter hose	300 gallons per hour
⅝ inch diameter hose	500 gallons per hour
¾ inch diameter hose	600 gallons per hour
washing car with a hose with a pistol grip shutoff	15 or more gallons
washing car with running water from a hose for 20 minutes	100-200 gallons

WATER CONSERVATION MEASURES

The average American uses over 61,000 gallons of water per year. While the bathroom accounts for 75% of the indoor water use in a home, 40% of the water used in a home is flushed down the toilet. About 8% of the in-home water use takes place in the kitchen.

One person can save 5 gallons per time or around 3,650 gallons per year if they turn the water off while brushing their teeth and shaving. Leaky toilets, faucets, showers and pipes can account for 10% of the water and sewer bill, and efficient shower heads can reduce water use by 50% and inexpensive faucet aerators can decrease water flow by 25% or more.

A normal household wastes as much as 40% of the water they use. Nationwide, homes use 57% of the publicly supplied water. Public use and unaccountable losses account for 11% of the municipally supplied water, and the rest is used by business and industries.

Domestic Conservation Issues

Table 4

SUGGESTED WATER CONSERVATION MEASURES
Install mandatory water saving shower heads
Install mandatory low flow toilet devices
Restrict lawn watering to early morning hours and late evenings
Enforce conservation water-pricing scheme
Enforce restriction on grass portion of yard, low-water landscaping
Promote public education about conservation by television, radio, newsletter, etc.
Promote mandatory water metering in all cities
Enforce mandatory industrial and commercial reuse/recycle
Encourage pressure reduction
Eliminate once-through air cooling systems
Install leak detection and repair policies
Enforce installation of moderate uniform plumbing codes
Promote mandatory conservation for all communities
Promote regional water system
Enforce retrofit program.

Table 5

CONSERVATION IDEAS FOR SAVING WATER	
Ways to Save Water Outdoors	**Amount of Water Measure Saves****
Soak lawn once a week. If grass springs back when stepped on, don't water.	750-1500 gallons per month
Water trees and shrubs with a hand-held hose with a positive shut-off nozzle, bucket, or drip system.	*N/A
Water plants, trees, and shrubs only between 4 p.m. and 9 a.m. when there is less evaporation.	300 gallons per month
Replace sprinklers with drip irrigation systems whenever possible.	½-4 gallons per minute
Use a broom, never a hose, to clean paved areas.	150 or more gallons per time
Wash vehicles with hand-held hose with a positive shut-off nozzle and a bucket.	15 or more gallons per time
Wash vehicles with water saved from indoor use or use a commercial car wash that recycles water.	*N/A
Install covers on pools and spas to cut down on evaporation. It will also keep water cleaner and reduce the need to add chemicals.	1300 gallons per month
Plant drought-resistant trees and plants.	750-1500 gallons per month
Put a layer of mulch around trees and plants to slow the evaporation of moisture.	750-1500 gallons per month
Check and fix leaks in pipes, hoses, faucets, and couplings.	20 gallons per day per leak
Seek out and repair any pipeline and irrigation system leaks.	*N/A
Direct the water drain line from evaporative air conditioners onto a flower bed, tree base or lawn.	*N/A
Be sure sprinklers water only lawn, not the pavement.	500 gallons per month
Never water on a windy, rainy or very hot day.	200-300 gallons per time
Plant less grass, more shrubs and ground cover.	*N/A
Water shrubs and gardens using a slow trickle around roots.	*N/A
Wash items like bikes and trash cans on lawn.	*N/A
Set mower blades one notch higher for less evaporation.	500-1500 gallons per month
Drive car onto lawn when washing it so rinse water waters grass.	150 gallons per time
Discourage kids from playing with hose.	600 gallons per hour

Ways to Save Water Indoors	Amount of Water Measure Saves**
Check your toilets for leaks. Put a few drops of food coloring in your toilet tank. If the color begins to appear in the bowl without flushing, you have a leak.	400 gallons per month
Flush toilet less often.	*N/A
Don't use your toilet as an ashtray or wastebasket.	400-600 gallons per month, 3-7 gallons per flush
Put a displacement bag, plastic bottle or other device in your toilet tank to reduce the water used.	5 gallons per day
Take shorter showers.	700 gallons per month, 5-10 gallons per minute
Install water-saving shower heads.	500-800 gallons per month
Close bathtub drain before turning on water.	3 gallons per time
Fill bathtub only halfway.	5 or more gallons per time
Install 1.6 gallon ultra-low-flush toilets.	1.4-5.4 gallons/flush
Capture and reuse warm-up water.	*N/A
Turn off the water while brushing your teeth and shaving.	3 gallons per day
Fully load your automatic dishwasher and washing machine.	75-200 gallons per week
Set your automatic washing machine to proper water level.	*N/A
Keep a bottle of drinking water in the refrigerator.	200-300 gallons per month
Use least amount of detergent possible to reduce dish rinsing time.	50-150 gallons per month
Fill sink or basin when washing and rinsing dishes.	8-15 gallons per day
Use spray device or short blast to rinse dishes.	200-500 gallons per month
If you wash dishes by hand, don't leave the rinse water running.	*N/A
Defrost frozen food without running water over the packages. Defrost in microwave.	50-150 gallons per month
Use the garbage disposal less and the garbage can more.	50-150 gallons per month, 2-7 gallons per minute
Rinse vegetables in a filled sink or pan instead of under running water.	150-250 gallons per month, 4-8 gallons per day
For major hand cleaning, use a waterless hand cleaner.	7-10 gallons per time
Fix leaky faucets and plumbing joints.	20 gallons per day per leak
In restaurants, accept water only if you want it.	*N/A

*Data not available for this conservation measure.

** The amount saved is based on a typical household size of three people for categories dealing with indoor water conservation measures.

Table 5 lists a variety of ideas for domestic water conservation. The table separates the indoor and outdoor water conservation measures. It also lists the amount of water that can be saved by implementing the conservation measure. Conservation can save water, energy, reduce wastewater treatment costs, and reduce the need to develop new sources of supply.

For more information about water saving ideas by water source see Table A-3 in the appendix. The conservation data was collected from a variety of brochures and pamphlets.

Commercial and Industrial Conservation Issues

A demand management strategy can be used to reduce commercial and industrial water use. The program can control water costs, energy costs, sewage disposal costs, treatment plant costs, and enhance community relations.

Table 6 summarizes the most common conservation measures used by industry and table 7 lists the steps to establishing an effective demand management program and the four target areas of the demand management program.

In pursuing conservation measures in industry demand management conservation programs start by assigning someone to be in charge, conducting a water audit, investigating water reuse, invest in conservation technologies, designing conservation into new facilities, reducing operation and maintenance water use, reducing water use for sanitary purposes, reducing water use for landscaping and air conditioning, scheduling irrigation to reduce water use, and considering water reuse when they can.

Table 6

CONSERVATION MEASURES USED BY INDUSTRY
Monitor water use
Promote employee education
Promote recycling
Enforce reuse of water
Enforce reuse of cooling tower water
Install equipment modifications
Use improved landscape irrigation
Eliminate once-through cooling systems

Table 7

DEMAND MANAGEMENT PROGRAM	
Steps for Establishing the Program	**Target Areas for the Program**
1. Develop a written corporate water policy to which staff and management can be committed.	1. Use closed loop cooling systems for cooling and heating system. Nonpotable water can be used in cooling systems, or air cooling can be substituted for water cooling. Avoid excessive boiler and cooling tower blowdown.
2. Conduct a thorough water audit to give you information on where and how efficiently water is used.	2. Review all process systems to determine if present water uses are necessary and if latest water-saving technology is being utilized. Use alternative sources of water such as wells, rivers and ponds. Use multiple rather than single rinses.
3. Locate and fix leaks routinely.	3. Install efficient water saving fixtures such as faucet aerators, toilet dams, and shower heads that use 3 gallons per minute or less of water for sanitary use. Install low-flow toilets. Encourage employees to report leaks and promote water saving habits.
4. Reassess how you use water.	4. Document and enforce a routine leak detection and repair program for maintenance operations. Install spring-loaded valves or timers on all manually operated water outlets. Reduce water use for landscaping, gardening or grounds keeping or consult a landscaper about low water use plantings and techniques. Put automatic shut-off nozzles on all hand-held hoses.
5. Install water-efficient machinery and fixtures.	
6. Educate your employees.	

Supplier Conservation Issues

Suppliers can influence water conservation attitudes and enforce water conservation in a variety of ways. Table 8 identifies the ways a supplier can affect water conservation.

Table 8

STEPS FOR ENFORCING WATER CONSERVATION ATTITUDES AND WATER CONSERVATION
Meter all water users
Adopt a pricing scheme that encourages conservation
Increase billing frequency
Find and repair leaks in water pipes
Link hookup fees for new users to conservation measures
Reduce excess pressure in water pipes
Encourage the installation of water-efficient plumbing fixtures
Reuse treated wastewater where appropriate
Include conservation in forecasting future water demand
Adopt water-efficient plumbing and building codes
Promote a program to retrofit plumbing fixtures in older buildings

There are seven major steps a municipality can take to evaluate the implementation of water conservation measures. Table 9 identifies these steps.

Table 9

STEPS FOR EVALUATING THE IMPLEMENTATION OF WATER CONSERVATION MEASURES
Identifying the potential conservation measures; etc.
Analyzing implementation conditions
Determining the effectiveness of the measures
Determining the advantageous effects of each measure
Determining the disadvantageous effects of each measure
Evaluating each measure
Developing an integral implementation plan

For step three, you must determine the fraction reduction in water use, the coverage or market penetration and the projected water use without conservation. For step four, indirect advantageous effects include energy savings, other economic advantageous effects, environmental quality advantageous effects, short-run incremental costs, long-run incremental costs, external opportunity costs, and foregone costs of water supply sources and alternatives. Finally, for step five, disadvantageous effects include implementation costs as well as other disadvantageous effects for the economy and the environment.

State Water Conservation Issues

There are several ways the state can influence conservation issues. The state can adopt a ground water resource protection ordinance, require water conservation by developers, set up public education programs for water users, require mandatory metering of all water uses, require a uniform pricing system directed toward water conservation, support retrofit and water saving devices, and develop an emergency water conservation plan.

Case Studies

Tucson currently has a water conservation program. They saved 51% of their water use by adopting plumbing code restrictions. They also saved 29%, 10%, 6%, and 4% by installing a landscape ordinance, instituting a public education program, increasing water rates, and hiring a landscape advisor, respectively.

Illinois also has a water conservation plan. For this plan:

- All new water services are metered;
- All existing unmetered services be metered as part of any major remodeling;
- In all new construction and in all repair and/or replacement of fixtures or trim, water efficient fixtures must meet the following criteria:

toilets, tank type	3.5 gallons/flush
toilets, flushometer type	3.0 gallons/flush
urinals, tank	3.0 gallons/flush
urinals, flushometer type	3.0 gallons/flush
shower heads	3.0 GPM
lavatory and sink faucets	3.0 GPM

- All new or replaced water cooled air conditioning equipment be closed system type;
- All lavatories for public use be equipped with metering or self-closing faucets; and
- All new or remodeled car wash installations be equipped with a water recycling system.

STATUS OF WATER CONSERVATION PLANNING IN THE METROPOLITAN AREA

To date, there is no overall coordinated plan for water conservation in the Metropolitan Area. But because water is so important to the well-being of society, there are many federal, state and local agencies involved in water conservation. There are private programs as well. The most important of them are described below.

One of the problems created by the fact that so many agencies have at least the potential for being involved in water conservation is that each one is only responsible for a small part of water conservation, and it is often not central to their primary mission. This may mean that little attention is paid to conservation programs. It also means that water conservation programs are not well coordinated with each other.

FEDERAL INVOLVEMENT IN WATER CONSERVATION

Several departments and agencies of the federal government have programs that address, or can address water conservation. Prior to 1978 no federal position on water conservation existed. In 1978, President Jimmy Carter issued a water policy message directing all federal agencies to consider water conservation as a national priority and to incorporate it into their programs. Interagency task forces were formed and identified changes necessary to implement a national water conservation policy. Although the Reagan administration left President Carter's directive intact, budget cuts and bureaucratic procedures prevented immediate implementation of the proposed changes.

Federal departments and agencies of the federal government with substantial responsibilities for water conservation include:

Department of Agriculture

Agricultural Stabilization and Conservation Service (ASCS)

Three programs carried out under the Agricultural Stabilization and Conservation Service have potential effects on water conservation. The Conservation Reserve Program conserves and improves soil and water resources on highly erodible and environmentally sensitive cropland by establishing a cover of grass or trees. The Agricultural Conservation Program (ACP) is designed to meet some of the more pressing farm-related conservation, water quality and environmental problems by providing a cost-sharing of up to 80 percent to farmers to carry out needed conservation projects. The Water Bank Program provides annual payment over 10 years for preventing the serious loss of wetlands and for preserving, restoring, and improving inland fresh water in important migratory waterfowl areas.[19]

Farmers Home Administration (FmHA)

Besides administering the Soil Conservation Service loans described below, the Farmers Home Administration makes farm ownership loans, Watershed Protection and Flood Prevention Loans, Resource Conservation and Development Loans and Community Program Loans, as well as Guaranteed Drought and Disaster Loans.

Soil Conservation Service (SCS)

The Soil Conservation Service has responsibility for developing and carrying out a national soil and water conservation program through technical help to locally organized and operated conservation districts. The main goal of the program is to protect and preserve soil, but water conservation is a benefit, since better water management is one of the ways to achieve reduced erosion.

Responding to President Carter's Water Quality Initiative, the SCS developed a five-year plan in 1989 to direct its activities relative to water quality and quantity. The SCS cooperates with other federal, state and local agencies to study watersheds of rivers and other waterways, including cooperative river basin surveys and flood plain management studies.[20] The service has general responsibility for administering, in cooperation with local sponsors, the installation of works of improvement to reduce erosion, floodwater, and sediment damage; as well as to conserve, develop, utilize and dispose of water. The loans the SCS makes to local agencies to install these improvements are administered by the FmHA.

Department of the Army

Corps of Engineers (ACOE)

The Army Corps of Engineers programs addressing water conservation are based on their responsibility for administration of laws for protection and preservation of navigable waters and related resources such as wetlands. In response to President Carter's directive in 1978 that all federal programs incorporate water conservation, the ACOE prepared manuals on how conservation could fit into their programs. Two of these were:

> The Role of Conservation in Water Supply Planning, April 1979, and
>
> Evaluation of Water Conservation for Municipal and Industrial Water Suppliers: A Procedures Manual, March 1980.

The other response was to improve the management and operation of locks and dams, reservoirs, and other Corps facilities. The ACOE was directed to prepare plans to reduce water use and loss. Water conservation was to be considered when reviewing and issuing permits.[21]

ACOE planning for future projects is based on the assumption that conservation and drought contingency planning are already underway before new source developments are considered. If these plans have not been prepared, the ACOE will help develop them.

Emergency water shortage planning was addressed in the Corps' Mississippi River Headwaters Lakes in Minnesota; Low Flow Review published in October 1990.[22] The report concluded that "the routine low flow discharge rates for each project lake are adequate for present needs." According to the report, "The relative priority for use of Federal project waters at the Headwaters projects is commercial navigation first, Treaty Trust resources second and general public good third." The report also states that additional emergency releases at critical low flows will be considered, but only if conservation programs are in place by downstream water users.

The report did contain some proposed changes to the low flow plan, including:

1. Interagency coordination procedure with specific triggers for stepped responses as conditions worsen, including identification of low flow emergency conditions in the Minneapolis-St. Paul Metropolitan area;

2. Organization of the St. Paul District in-house drought management team; and

3. Preparation and use of a public information plan specific to droughts.[23]

Department of Commerce

National Oceanic and Atmospheric Administration (NOAA)

Among its responsibilities, NOAA provides weather forecasts to the general public and issues warnings against destructive natural events, such as hurricanes, tornadoes, floods and tsunamis. It also conducts an integrated program of research and services related to the oceans and inland waters. It acquires, stores and disseminates worldwide environmental data.[24]

Department of Energy

The Chicago Operations Office reported the following programs related to water conservation:

Conservation and Renewable Energy

- Energy Conservation Research and Development
- State and Local Assistance Grants

Environmental Restoration and Waste Management

- Environmental Restoration

Environmental Protection Agency (EPA)

The Environmental Protection Agency was created to permit coordinated and effective governmental action on behalf of the environment. The agency's water quality activities represent a coordinated effort to restore the nation's waters. The functions of this program include:

- Development of national programs, technical policies, and regulations for water pollution control and water supply;
- Ground water protection;
- Marine and estuarine protection;
- Enforcement of standards;
- Water quality standards and effluent guidelines development;
- Technical direction, support, and evaluation of regional water activities;
- Development of programs for technical assistance and technology transfer; and
- Provision of training in the field of water quality.[26]

Department of the Interior

United States Fish and Wildlife Service

The Service provides leadership for the protection and improvement of land and water environments, which directly benefit the living natural resources and adds quality to human life. Activities include:

- Ecological studies;
- Environmental impact assessment, including hydroelectric dams, nuclear power sites, stream channelization, and dredge-and-fill permits; and
- Environmental impact statement review.[27]

Geological Survey (USGS)

Among the primary responsibilities of the Geological Survey are investigating and assessing the nation's land, water, energy and mineral resources. It conducts nationwide assessments of the quality, quantity and use of the nation's water resources. It publishes the results of its investigations in thousands of new maps and reports each year.[28] In Minnesota, the USGS conducts these efforts in cooperation with the DNR.

Bureau of Land Management

Among its other responsibilities, the Bureau of Land Management manages watersheds to protect soil and enhance water quality.

Bureau of Reclamation

In the early years of this century, the Reclamation Service of the Department of the Interior was created to administer a reclamation program that would provide the arid and semiarid lands of the 17 contiguous western states with a secure, year-round water supply for irrigation. As water needs increased, the Bureau of Reclamation expanded its mission and now provides water for farms, towns, and industries. It is also responsible for the generation of hydroelectric power, river regulation and flood control, outdoor recreation opportunities, and the enhancement and protection of fish and wildlife habitats.[29]

Department of Justice

Environment and Natural Resources Division

The Environmental and Natural Resources Division brings civil and criminal enforcement cases primarily on behalf of the Environmental Protection Agency for the control and abatement of pollution of air and water resources. In addition, the division represents the United States in cases where the government supports rights claimed by individual Indians or Indian tribes, including suits to establish water rights.[30]

Small Business Administration (SBA)

The Small Business Administration provides loans to state and local development companies and to small business concerns.[31]

INTERNATIONAL JOINT COMMISSION--UNITED STATES AND CANADA

The purpose of the Commission is to prevent disputes regarding the use of boundary waters. The Regional Office monitors, evaluates and encourages compliance with the Great Lakes Water Quality Agreement of 1978.[32]

WATER CONSERVATION PROGRAMS AT THE STATE LEVEL

The water law of the state of Minnesota is cited in Minnesota Statutes, chapters 103A through 103G. The state of Minnesota's basic posture towards water conservation is reflected in two statutes. In defining the purpose of Minnesota Environmental Rights Law (Minn. Stat., Ch. 116B.01) the legislature found and declared that:

> . . . each person is entitled by right to the protection, preservation, and enhancement of air, water, land and other natural resources located within the state and that each person has the responsibility to contribute to the protection, preservation, and enhancement thereof. The legislature further declares its policy

> to create and maintain within the state conditions under which human beings and nature can exist in productive harmony in order that present and future generations may enjoy clean air and water, productive land, and other natural resources with which this state has been endowed.

The state's water law contains a special policy on rainwater.

> It is the policy of the state to promote the retention and conservation of all water precipitated from the atmosphere in the area where it falls, as far as practicable. (Minn. Stat., ch. 103A.205)

Other citations from Chapter 103 occur within the following program descriptions, and in another Council report on water institutions (Working Paper No. 8), still in preparation.

Environmental Quality Board (EQB)

The Environmental Quality Board (EQB) is the state's principal forum for discussing environmental issues. It manages the Environmental Impact Statement (EIS) program which provides information to units of government and the public on the environmental impacts of a proposed project before government permits and approvals are given. One of its responsibilities is to identify environmental issues of concern to the state. It is to initiate, coordinate and continue to develop comprehensive long-range state water resources planning.[33]

The EQB has absorbed some of the functions of the Water Planning Board (WPB) which was created in 1977 and directed to prepare a water and related land resources plan, to coordinate and develop comprehensive long-range water planning, to initiate studies, to coordinate public water resource management and related activities among state agencies, plus conduct other water planning activities. Under the WPB, several technical papers were developed dealing with water conservation.

The WPB adopted and promoted an efficient use/anti-waste definition of conservation, rather than an anti-use concept. The WPB also supported the view that water conservation programs should develop at the local level, and that the state's role should be one of technical assistance. As early as 1979, the WPB recommended that "the state should take the lead in obtaining, evaluating and disseminating information on conservation techniques through an education and technical assistance program."[34] The WPB is no longer in existence.

Minnesota Statutes, Section 103B.151 required the Environmental Quality Board to develop a "new plan and strategy" by Nov. 15, 1990 to update the plan prepared by the Water Planning Board in 1979.[35] The result, the Minnesota Water Plan, was prepared by the EQB Water Resources Committee and adopted by the EQB in November 1990. It was developed to guide water planning and management activities in the State of Minnesota. Not a regulatory document, it identifies principles and proposes policies to protect and conserve Minnesota's water. Local water plans are a major foundation for the plan.[36]

The plan describes Minnesota's water goals as follows:

> To improve and maintain the high quality and availability of Minnesota's water for future generations and long-term health of the environment.
>
> To ensure that our uses of water are sustainable, and that in meeting our needs for water, we recognize its limits and inter-connections, accept its changing and variable nature, and adjust our demands upon it when necessary to safeguard it for future needs.[37]

The Minnesota Water Plan identifies 14 ten-year objectives and 28 major recommendations. It also assigns major responsibilities.

One of the ten-year objectives is "to develop a coordinated local-state effort that sustains water resources for basic necessities, environmental protection, and economic production." Under this objective, recommendation no. 26 is to "develop a water conservation strategy for long-term and seasonal water use throughout Minnesota." In order to ensure adequate supplies, the Minnesota Water Plan recommends that the state:

- Continue to implement the Drought Contingency Plan;
- Work toward restricting non-essential use of aquifers, such as lawn watering; and
- Eliminate use of ground water for "once-through systems."

In addition, "appropriators need to have water contingency plans for emergencies and drought that include water conservation measures."[38]

The Minnesota Water Plan directs local government to:

- Explore use of flood storage areas for domestic water supplies, as well as various other uses;
- Consider the advantages of merging utilities or sharing water supplies; and
- Adopt land use controls to protect the quality of water supplies.

Initial actions needed to begin addressing these recommendations and the agencies with primary responsibility are:

- Examine rate schedules, water uses subject to charges, and effects charges have on use. (DNR, MDH)
- Refine priorities for water use and define essential and non-essential use. (DNR)
- Explore the reuse of "gray water" (e.g. water from showers, sinks) for uses such as gardens. (MDH, MPCA)

- Establish criteria for interbasin transfers and strategies for managing water supply needs within the "basin of origin" to safeguard long term water quality and quantity. (DNR)

- Complete the Metropolitan Area water use and supply plan including evaluating a regionally planned, locally operated, Twin Cities Metropolitan Area water supply system. (Metropolitan Council)

- Establish a pricing system that ensures treatment costs do not provide barriers to water supply sharing. (MDH, UM)[39]

The State of Minnesota has a number of agencies authorized by law to administer water-related programs. Eight state agencies can have a substantial impact on water conservation.

Department of Natural Resources (DNR)

The Department of Natural Resources is the state agency with the greatest authority over water use. The commissioner of the DNR has authority over all of the public lands, parks, timber, waters, minerals and wildlife of the state and their use, sale, leasing or other disposition.[40]

Under state law, the commissioner is required to "develop and manage water resources to assure an adequate supply to meet long-range seasonal requirements for domestic, municipal, industrial, agricultural, fish and wildlife, recreational, power, navigation and quality control purposes from waters of the state" (Minn. Stat., ch. 103G.265, subd. 1).

As part of this requirement, the commissioner of DNR is to "develop a water resources conservation program for the state [including] conservation, allocation, and developing of waters of the state for the best interests of the people." (Minn. Stat., ch. 103G.101 subd. 1)

The commissioner is to be guided by this program in issuing permits for the use and appropriation of the waters of the state. No separate water conservation planning document has been created by the DNR. The directive cited above is carried out through its water appropriation permitting program.

Over the past year, the Division of Waters has encouraged local communities to develop a water conservation plan. As amendments to water appropriation permits are requested, the division sends out Water Conservation and Contingency Planning, a document that helps a community assess its water use and conservation practices. In cases where they think a community could save water, rather than drill a new well to meet peak demand every year or so, they may send the document and inform the community that they will require that the survey be completed and returned before issuing another amendment to the community's permit.[41]

The Division of Waters of the DNR also regulates activities conducted in the beds of protected waters, regulates water appropriations and various land use activities in shoreland and floodplain areas.

The Water Allocation Unit within this division administers the regulatory program for water appropriation or use. As explained in a brochure produced by DNR entitled "Minnesota's Water Appropriation Program":

> Minnesota's water appropriation law is based on the English common law doctrine of 'riparian right,' modified by the concept of 'reasonable use.' Under this system, the owner of the land abutting a surface water body or overlying a ground water source has the right to make 'reasonable use' of the water, subject to the equal rights of other riparian owners to use the water for similar purposes. There is no 'first in time, first in right' as with the 'appropriative rights' doctrine which is common in the Western United States. If there is insufficient water to supply all demands, each landowner may be required to limit their water use to allow for new water users.

In 1989, in Minnesota Statute 103G.261, the legislature revised the former priority system as follows:

- First Priority. Domestic water supply, excluding industrial and commercial uses of municipal water supply and use for power production that meets the contingency planning provisions of section 103G.285, subd. 6, which requires that a contingency plan be submitted by an applicant for surface water appropriation.

- Second priority. A use of water that involves consumption of less than 10,000 gallons of water per day.

- Third priority. Agricultural irrigation and processing of agricultural products, involving consumption in excess of 10,000 gallons per day.

- Fourth priority. Power production in excess of the use provided for in the contingency plan developed under section 103G.285, subd. 6, as explained under first priority use.

- Fifth priority. Uses other than agricultural irrigation, processing of agricultural products and power production, involving consumption in excess of 10,000 gallons per day and nonessential uses of public water supplies as defined in section 103G.291, subd. 1(b). (This section provides that if the governor issues an executive order determining that there is a critical water deficiency, public water supply authorities appropriating water must adopt and enforce water conservation restrictions within their jurisdiction that are consistent with rules adopted by the commissioner. These restrictions must limit lawn sprinkling, vehicle washing, golf course and park irrigation, and other nonessential uses. Disregard of critical water deficiency orders is grounds for immediate modification of a public water supply authority's water use permit.)

Minnesota Rules Part 6115.0620, developed in response to these statutes, requires that a permit be obtained for any appropriation of surface water or ground water for any use in excess of 10,000 gallons per day or one million gallons per year. A few uses are exempt from permit requirements:

- Appropriation of water for domestic uses serving less than 25 persons for general residential purposes;
- Test pumping of a ground water source;
- Agricultural drainage systems to remove water from crop lands;
- Reuse of water already authorized by a permit.

The permittee must report annual water use to the department's Division of Waters and pay an annual fee. These fees were increased by the Minnesota legislature in 1990 to be more reflective of the costs of issuing permits.

As of May 1990, there were 6,000 active water appropriation permits in Minnesota:

- 4,000 permits for agricultural irrigation;
- 1,000 permits for public water supply; and
- 1,000 permits for mining, industrial, commercial, agricultural processing and various other uses.[43]

In the Metropolitan Area in 1990, there were 1,773 active water use permits. Table 10 lists the number of permits in the nine water use categories.

Table 10

ACTIVE WATER USE PERMITS IN THE TWIN CITIES METROPOLITAN AREA

NUMBER OF PERMITS	WATER USE
432	Municipal waterworks
81	Private waterworks
306	Commercial and Institutional
109	Commercial Air Conditioning
15	Power Generation
98	Water level maintenance (suspended)
118	Sewage Treatment
11	Miscellaneous uses
603	Irrigation
1,773	TOTAL

Minnesota Statutes 103G.285 provide that the commissioner of DNR may place restrictions on water-use appropriations permits to safeguard water availability during periods of low flow. In order to safeguard water availability for instream uses, and for downstream higher priority users near the site of appropriation, DNR can establish limits so that consumptive appropriations that would interfere with this use are not made.

DNR must also set limits on appropriation of surface water within water basins below which withdrawals cannot be made.

Minnesota Department of Health (MDH)

The Minnesota Department of Health is involved in water conservation from the standpoint of public health. The department has the authority to develop emergency plans when, for reasons of water shortage or contamination, a water supply creates an unacceptable health risk. The MDH is authorized to take all necessary steps to preserve sources of domestic water supply from pollution. Minnesota Statutes 144.35-37 prohibits the discharge of sewage or other matter to a source of domestic water supply if such discharge will impair health.

The Environmental Health Division is responsible for protecting the public from potential health hazards associated with drinking water, swimming pools and beaches and individual sewage treatment facilities.

The Water Supply and General Engineering Section is responsible for enforcing state and federal safe drinking water laws. It reviews and approves plans for public water supply systems and public swimming pools. It licenses well-drilling contractors and certifies water supply operators. It licenses plumbers, water conditioning contractors and installers, if working in a community with a population of 5,000 or more.[44]

MDH is authorized to develop an emergency plan to protect the public when, for reasons of water quality or quantity problems, there is an imminent health risk (Minn. Stat. 144.383 d). This authority was used to prepare a contingency plan for St. Louis Park when their water supply was contaminated, and in 1982, when emergency provisions were invoked to satisfy peak demand.

In 1981 the MDH produced a report entitled, An Assessment of Minnesota Municipal Water Systems for Conservation Potential.

In order to protect public health, the MDH is also given authority to develop standards on plumbing installations (Minn. Stat. 326.37). The state commissioner of health may, by rule, prescribe minimum standards, which shall be uniform.

Rules were also adopted in response to the Minnesota Safe Drinking Water Act of 1977 (Minn. Stat. 144.381-387 and the National Safe Drinking Water Act PL 93-523). Under these rules, standards are given for water quality, monitoring and analytical requirements, record keeping and reporting of results. Also specified are rules for water haulers who distribute water by tank truck.[45]

Minnesota Pollution Control Agency (MPCA)

The Minnesota Pollution Control Agency (MPCA) is involved in water conservation from a water quality standpoint. By protecting the quality of the state's waters, the MPCA attempts to ensure the availability of a high quality source of water. Polluted water, even though available, may be unusable for health, aesthetic or other reasons.

The MPCA is also involved with permitting dischargers of wastewater effluent via the National Pollutant Discharge Elimination System (NPDES) program. Theoretically, the MPCA could control water use by limiting the discharge to certain volumes, thereby forcing dischargers to take in less water. This has not been done. Rather, the permitting process has indirectly resulted in water use reduction by raising disposal costs.[46]

Statutes that direct the MPCA's involvement in water are:

> Minn. Stat. 115.03 gives the MPCA the authority to administer and enforce all laws relating to the pollution of any waters of the state.
>
> Minn. Stat. 115.061 requires that any person with knowledge of a discharge, accidental or otherwise, of any polluting substance under its control into waters of the state to report that discharge to the MPCA. The statute also requires the person to take action to minimize and abate the pollution.
>
> Minn. Stat. 115.071 gives the MPCA authority to enforce regulations, standards, permits, schedules of compliance, stipulation agreements and orders.
>
> Minn. Stat. 115.42 directs the MPCA to prepare a long-range plan and program to define policies for protection of water quality and to report to the legislature in even-numbered years its recommendations for actions during the next biennium.
>
> Minn. Stat. 115.44 directs the MPCA to classify waters of the state and adopt water quality standards for the different classes.
>
> Minn. Stat. 116.11 gives emergency powers to the MPCA to stop any polluter from polluting (air, land, water) if such disposal poses an imminent and substantial danger to the health and welfare of the people of the state.
>
> Minn. Stat. 116.101 directs the MPCA to develop a statewide hazardous waste spill contingency plan. This plan is to be incorporated into the statewide hazardous waste management plans of the Office of Waste Management.[47]

Minnesota Board of Water and Soil Resources (BWSR)

The BWSR is the result of a 1987 merger of the Soil and Water Conservation Board, the Water Resources Board, and the Southern Minnesota River Basins Council.

> The board has policy-setting and decision-making responsibilities under the Soil and Water Conservation Law [Minn. Stat., ch. 103C], Comprehensive Local Water Management Act [Minn. Stat., ch. 103B.301], Minnesota Watershed Act [Minn. Stat., ch. 103D.201] and Metropolitan Surface Water Management Act [Minn. Stat., ch. 103B.201]; [it also] provides a forum for discussion of local water and soil resources management issues and resolution of statutory water policy conflicts.[48]

As explained in the agency's informational brochure, Minnesota Board of Water and Soil Resources:

> Through its plan approval authority, administration of state grants and technical assistance to [soil and watershed conservation and watershed] districts and counties, the BWSR coordinates the water and soil resource planning activities of these local units of government.
>
> As part of its mandate, the BWSR also develops information and education programs that stress the early detection and prevention of natural resources problems. . .
>
> . . . the BWSR has been given the authority to approve local water plans [and] provides technical assistance to local units of government doing comprehensive water planning.

Minn. Stat. 103F.501, the Reinvest in Minnesota (RIM) Resources Law, established a program to preserve the state's natural resources.

> RIM is made up of a variety of activities, some administered by the DNR, and others by the BWSR through local Soil and Water Conservation Districts. Each of these programs is set up to preserve a particular resource, but many benefit other resources as well. For example, RIM Reserve-Farmland Retirement is designed to control soil erosion, yet in many cases it also creates habitat for wildlife, improves water quality and helps the rural economy.[49]

One of the programs encourages the retirement of marginal, highly erodible land--particularly land adjacent to public waters and drainage systems--from crop production in order to reestablish a cover of perennial vegetation. This program, which compensates farmers for taking fragile and sensitive land and wetlands out of agricultural production, is administered by the BWSR in cooperation with other state agencies including the MDNR and the MDA. The program impacts water conservation by restoring wetlands as part of a total surface water management system. It improves water quality by reducing soil erosion.

Although the main thrust of their work is elsewhere, other state agencies impact water conservation.

Minnesota Department of Agriculture (MDA)

The MDA is involved with water quality through its authority over pesticides.

Minn. Stat. 18B.04 directs the MDA to determine the impact of pesticides on the environment, including the impacts on surface water and ground water in the state. It also requires the MDA to cooperate with and assist other state agencies and local governments to protect public health and the environment from harmful exposure to pesticides.

Minn. Stat. 18B.10 authorizes the commissioner to take action to prevent ground water contamination from pesticides.

Minnesota Department of Public Safety (DPS)

The Division of Emergency Management (DEM) of the DPS is responsible for coordinating actions of all agencies which have the capability and responsibility for emergency actions during disasters.[50] During critical water shortages, the DEM becomes involved through the provision of water, the coordination of other agency efforts, and the declaration of a drought emergency, so that federal relief programs will become involved.

Minn. Stat. 12.03 directs the DPS to provide emergency services to prevent, minimize and repair injury and damages resulting from disasters or acute shortages.

Minn. Stat. 12.22 authorizes the DEM to accept for the state offers of federal aid relating to civil defense.

Minn. Stat. 12.221 authorizes the DEM to enter into an agreement with the federal disaster assistance administration for the maintenance of the Minnesota Natural Disaster Assistance Plan.

The Combined Ability of State Agencies to Conserve Water

Under the Minnesota Environmental Rights Law, the legislature declared that "each person is entitled by right to the protection, preservation and enhancement of air, water, land and other natural resources. . ."

As cited above, Minnesota has a number of statutes providing for water conservation and a number of agencies involved in water conservation. The DNR is charged with developing a water resources conservation program for the state which it carries out through its appropriations and permitting program.

The MPCA and MDH are responsible for maintaining good water quality. The MDH has the authority to revise the plumbing code to encourage wise use of water with water saving devices. To date two such changes have been made, not by revising the plumbing code, but by other actions. One was made by statute providing for a maximum flush volume of 1.6 gallons for all new floor-mounted toilets installed in areas under the jurisdiction of the state plumbing code,

beginning January 1, 1993. The other change was accomplished through the Model Energy Code adopted by the state. This restricts the maximum flow of new showerheads to three gpm.

Other statutes dictate the role of various agencies in providing water to users in emergency situations. The DNR is charged with requiring user contingency plans under certain permitting conditions. The MDH must provide plans to ensure a safe supply. The DPS takes charge of emergencies and coordinating the response.

WATER CONSERVATION PROGRAMS AT THE LOCAL LEVEL

Despite state oversight of these aspects of water conservation, much of the basic responsibility for water conservation is left to local agencies.

Major legislation affecting local units of government and local planning for water include:

> The Soil and Water Conservation Law (Minn. Stat., ch. 103C) which authorizes the establishment and operation of special purpose units of local government called soil and water conservation districts (SWCDs). These districts encourage land owners and occupiers to conserve soil and water resources through use of conservation practices that reduce or prevent soil erosion, sedimentation and nonpoint pollution in order to preserve the natural resources and achieve other benefits.[51]
>
> The Comprehensive Local Water Management Act (Minn. Stat., ch. 103B.301) encourages each county outside the Twin Cities Metropolitan Area to develop and implement a comprehensive water plan addressing both surface and ground water.[52]
>
> The Watershed Act (Minn. Stat., ch. 103D.201) allows the establishment of watershed districts to facilitate coordinated water resources management over the drainage basin of a lake or river system.[53]
>
> The Metropolitan Surface Water Management Act (Minn. Stat., ch. 103B.201) requires the preparation and implementation of watershed plans within the Twin Cities Metropolitan Area. Ten of the watersheds are organized watershed districts and 36 are joint powers watershed organizations formed among cities and townships. The primary purpose of the act is to preserve natural water storage areas as development takes place in order to manage surface water and avoid flooding, erosion and poor water quality.[54]

Under a framework established in Minnesota Statute 103B.255, Metropolitan Area counties can prepare ground water plans. Ground water components in management plans, prepared by Watershed Management Organizations (WMO), have to be consistent with county plans. Watershed management organization plans for surface water must be reviewed by the respective affected counties and cities, the Metropolitan Council, the MPCA, the DNR, and the BWSR. As of June 15, 1991, 38 of the 46 plans had been reviewed by the Council. Water planning work at the local level has dealt principally with runoff. It has not really addressed water supply. A link needs to be supplied between these two types of water planning.

Much of the responsibility for planning and implementing water conservation lies at the local level. Although water supply planning can go on at all levels of government, the agency supplying the water has the prime responsibility. Hence the emphasis on local water plans.

The water supplier must develop adequate sources, make sure that the water is safe and potable, and deliver it in a cost effective way to the user. Another reason for putting the emphasis on local water plans is that water shortages in Minnesota are often a local phenomenon. Although plans must be tailored to local conditions, good planning for water conservation shares some common characteristics.

Some communities have found that projected costs for new wells are substantial. White Bear Lake estimates that a new well in 1995 will cost between $250,000 and $300,000 for the well alone.[55] Orono has a new well near completion. It estimates the total for the well and pump will be $211,000. Eden Prairie projects the need for six more wells. The cost of the wells, well houses, collector lines and site work is estimated at $2,250,000. An additional $135,000 will be spent in architectural costs associated with building park shelters as part of the project.[56]

Water conservation efforts of local units of government in the Metropolitan Area are listed in Table A-2 in the appendix. Some examples were included as part of the discussion of supply and demand management practices in water conservation in a previous section of this report.

WATER CONSERVATION IN THE COMMERCIAL/INDUSTRIAL/INSTITUTIONAL SECTOR

In Water Demand in the Twin Cities Metropolitan Area, Working Paper No. 2, the projected commercial/industrial/institutional water use in the Twin Cities Metropolitan Area was estimated to be 64,470 mgy in 1990, and projected to increase to 65,986 mgy in 2000 and 67,408 in 2010. This represents about 16 percent of the total water use.[57]

In the past in the Metropolitan Area, water has been considered a free raw material, easily available and appropriated. The only costs calculated were those of installing wells and their associated equipment, the distribution system and energy costs needed to run the system plus a small DNR permit fee. Energy costs have risen, and the Twin Cities Metropolitan Area is not an "energy rich" region. One other increasing cost--waste disposal--has prompted some large-volume users to seek ways to conserve water. Industrial uses include water used for processing and cooling machinery. Some plants use municipal supplies, others are self-supplied.

When the Metropolitan Waste Control Commission (MWCC) instituted its strength charge for discharges into the metropolitan sewer system, users discharging high strength waste into the system had an incentive to reduce their wastewater flow, its strength and their costs. The MWCC assisted some companies in strategies to accomplish this, since it would reduce flow to the wastewater treatment plants. Two examples are the Stroh Brewery and the Waldorf Corporation. Both companies revised their processing system, gained product and thus reduced costs. This, in turn, reduced the load on MWCC wastewater treatment plants.

Another factor in water conservation has been pretreatment of metal-bearing wastes, with metals recovery being involved in some cases. A number of large companies have installed their own systems to accomplish this and meet standards, while some other medium and small companies are using a metals recovery facility in Roseville. In either situation, methods are generally employed to greatly reduce process water rinsing volumes, since treatment is much easier for smaller volumes of water. This has resulted in lower water use at many companies, less metals in MWCC treatment plant sludge, and sometimes the treated water can even be reused at the companies.

A metal plating company in the area changed their rinsing process, reused the water and reduced their wastewater discharge from 15 million gallons a quarter (mgq) to 6 mgq. Water conservation measures at another metal plating company reduced discharges from 45 mgq to about 25 mgq. By changing their processes, the companies reduced their wastewater charges and less water went to the treatment plant.[58]

3M, one of the country's leading manufacturing companies, has established a program called 3P Plus (Pollution Prevention Pays). This program concentrates on reducing pollution at the source through:

- Product reformulation;
- Process modification;
- Equipment redesign; and
- Recycling and reuse of waste materials.

In the 15 years between 1975 through 1989, 3M calculates that this program has prevented 15,300 tons of waste pollutants from being generated at their plants in the United States, and saved a billion gallons of wastewater. These figures represented savings from only the first year of each project. Projected over a period of years, even more significant savings were realized.[59]

At the 3M Chemolite Center plant in Cottage Grove, ammonium sulfate, a by-product of the manufacture of magnetic oxides for recording products, was passing through the plant's system virtually untreated into the Mississippi River. When state regulations required a reduction of ammonia from the Chemolite effluent, 3M installed a vapor compression evaporator which recovered a 40 percent solution of ammonia. This could be sold to local farmers as fertilizer. Although the vapor compression equipment cost $1.5 million, installing it eliminated the need for $1 million in water pollution equipment, and saved 677 tons of wastewater. The plant met pollution control requirements and annual sales of fertilizer of $150,000 will pay back the cost difference in a few years.[60]

Hennepin Paper Company manufactures colored construction paper. They have been working on a zero-discharge system for process water since July, 1990. They are currently trying to (1) determine the impact of water quality on pumps, piping and other equipment, (2) investigating various technologies to improve the quality of the reused water, (3) simulating the paper making process in the laboratory to identify the toxic agent to the bioassay organism Ceriodaphnia *dubia* and locate its source, and (4) implementing what is learned into their production process.

Avtec Finishing Systems, Inc. in New Hope, NICO Products, Inc. in Minneapolis, and Micom Corp. in New Brighton investigated the technical and economic feasibility of the treatment and recycling of rinse water from metal finishing operations using ion exchange. The annual sludge

generation rate dropped significantly when the rinse water was reused after the ion exchange process, as opposed to using fresh water in the rinse tanks and discharging it to the sewer after ion exchange. The zinc chloride rinse water generated an estimated 9,287 gallons of sludge a year with water recycling compared to 17,821 gallons per year without reuse. The copper rinses generated 728 gallons a year with rinse water as opposed to 7,259 gallons without reuse. Rinse water recycling for combined chrome rinses was reduced from 1,680 to 840 gallons and the zinc cyanide rinse was reduced from 401 to 278 gallons.

Plating, Inc. and Technologies, Inc. investigated and implemented a system for recovery and recycling rinse water and dragged-out plating bath following zinc cyanide plating. They applied reverse osmosis technology to a double-counterflow rinse following a 13,000 gallon zinc cyanide plating tank. The objective of the project was to reduce hazardous waste generation and assume compliance with wastewater discharge regulations. Plating, Inc. maintained its defect rate of 0.6 parts per million with the reverse osmosis system. Over eight months, 2,480 gallons of plating concentrate averaging 40% of bath strength were recovered and reused. This is an average of about 300 gallons per month.

Cinch Cylindrical Connection Division in Minneapolis ran a five month study in 1989 to determine a method to operate a low-volume, manual cadmium cyanide plating line without rinse water discharge and wasted plating bath chemicals. An analysis was also completed to include an acid copper sulfate line, a nickel sulfamate line and a silver cyanide line. A computer model to evaluate rinsing options was created and can be used by most plating shops. Net savings from the process are about $20 per week, mainly in the avoidance of post-treatment of an average 850 gallons per day of rinse water.

Printed Circuit Board Operation of Control Data Corporation and Water Technologies, Inc. investigated and implemented a system for recovering and recycling rinse water from electroless copper plating lines. The system applies reverse osmosis technology to the double counter-flow rinse following a 200-gallon electroless copper plating tank. The primary benefit of the reverse osmosis system has been the dramatic reduction in water use. Water consumption dropped from 300 gallons per hour to only 2.6 gallons per hour. Generation of hazardous waste sludge from the waste treatment system also dropped 2 percent.

OxiSolv Corp. investigated the development of an inexpensive system to recycle the rinse water from degreasing, paint stripping, and rust removal processes used in the automobile restoration facility. The system they developed enabled OxiSolv to reuse 300 gallons of water a day that was formerly sewered.

Honeywell Corporation changed some of its processes to conserve water. The company developed ways to reuse and recirculate the rinse water in the metal plating of small parts to put a protective coating on thermostats and valves. In another process, spray painting with a water curtain was changed to an electroplating process with a powder that does not use water.[61]

Some communities that encourage reuse/recycling programs at commercial/industrial facilities are listed in Table A-2, Water Conservation Efforts of Local Units of Government, in the appendix of this report. Among communities citing programs were Anoka, Fridley, Hopkins, Richfield, Shakopee, Savage and Spring Lake Park.

In other parts of the country, the Gillette Company in Boston reduced its water use from 730 mgy in 1972 to 156 mgy in 1982. As reported by the Massachusetts Water Resources Authority, this was

> a 78 percent reduction with an estimated payback period of 1.33 years (at 1982 rates.) Conservation methods included (1) employee awareness programs; (2) the installation of air conditioning process cooling loops; (3) a washing water recirculation system; and (4) the development of non-potable water sources.[62]

Another success story was the General Electric Company in Lynn, Mass. It has

> . . . over the last 10 years reduced its water use by more than 30 percent (1,365,000 gpd) by installing closed loop cooling systems and expanding the steam condensate return system. In 1988 GE saved an additional 11 percent of total water use entirely through aggressive maintenance repair and employee awareness effort. . . Since 1974, GE has invested more than $2 million in water conservation projects.[63]

Most of the recycling/reuse systems established by individual companies need to be specially designed to fit their particular application and location, but the payback seems to be very favorable in many cases.

The MWCC has expressed interest in water conservation as a way of conserving the resource, but at the same time emphasizes that the integrity of the existing system for meeting water quality standards and health standards must be maintained as their primary concerns.

There are also some concerns from the engineering standpoint. If the wastewater volume is reduced too much, the resulting concentrated wastewater might move slower, create anaerobic conditions and produce acids that damage the sewer collection system. All these considerations need to be met in planning water conservation programs affecting wastewater. Additional water conservation efforts are being explored by a MWCC study team.[64]

WATER USE FOR BUILDING HEATING AND COOLING

Space heating and cooling of buildings withdraws substantial amounts of ground water for once-through heating, ventilating or air conditioning systems. Most of this water is used once and discharged into the local storm or sanitary sewer system, ending up in rivers, creeks and other surface waters. Since water has been cheap and readily available, these systems have been used extensively in the Metropolitan Area. According to figures supplied by the DNR,

> In 1988 ground water withdrawals for space heating and cooling of buildings withdrew almost 11 billion gallons or nearly 20 percent of the total reported ground water use in Hennepin and Ramsey Counties. Almost all of this water is used in once-through heating and cooling systems.[65]

Responding to criticism of the large volumes of water used for such purposes, the 1990 legislature (Minn. Stat. ch. 103G.271, subd. 5) prohibited the issuance of water use permits to increase the volume of appropriation from a ground water source for once-through cooling systems using in

excess of 5 million gallons annually, and required the termination of permits using in excess of 5 million gallons annually by no later than Dec. 31, 2010. The legislation also required the conversion to water-efficient alternatives within the design life of the existing once-through systems.

Alternatives include district heating and cooling, cooling tower systems and closed loop systems. Some buildings that use the higher cost municipal water have already installed closed loop systems or cooling towers.

Reuse of this water is another alternative. Minnesota Rules (4725.2300) administered by the MDH state that ". . . water used for air conditioning, shall not be returned to any part of the potable system."[66] However, the rules do not specifically prohibit use of this water for processing applications, lawn and garden irrigation or other non-potable uses. Unless treated, heating and cooling water is not acceptable for reuse in the potable water supply, because of the possibility of contamination occurring while it is in the heating/cooling system.

About 10 percent of the discharge from these systems in Hennepin and Ramsey Counties is used for irrigation. To date, it has not seemed cost-effective in this area to establish systems for treatment and reuse of this water.[67] However, the changing water situation in the Metropolitan Area means that water reuse and reclamation will likely become more feasible in the near future. A function of a future regional water supply plan should explore reuse/reclamation for non-potable supply as a serious option to further development of new supply sources.

Systems for reuse have been established in other parts of the country. The Irvine Ranch Water District in Irvine, California provides reclaimed water to large users such as golf courses, school yards and parks. It also supplies small landscape uses such as street median landscaping and agricultural users. The water district is planning to expand its system to provide reclaimed water in high rise office buildings to flush toilets.[68]

In other areas, water has been reused for irrigation to reduce wastewater discharge.

WATER CONSERVATION IN THE MANAGEMENT OF WATER SHORTAGES

Most of the focus of this report has been on long-term water conservation. Water conservation measures are frequently used to cope with short-term water shortages occasioned by a drought or contamination of a supply. Few formal plans exist to aid communities in coping with short-term water shortages.

To provide a defined sequence of actions to be undertaken by Mississippi River users during periods of reduced river flow, a basic framework was assembled by the DNR and several other agencies in response to the Governor's Twin Cities Water Supply Task Force. This matrix is the basis of the short-term plan prepared by the Metropolitan Council to respond to water shortages on the Mississippi River prior to the adoption of a long-term plan. The matrix itemizes the responses by the six parties that use water, regulate water usage or coordinate activities on the river (the DNR, Minneapolis Water Works, St. Paul Water Utility, MWCC, Northern States Power and the Mississippi Headwaters Board).[69] This plan is described more fully in the

Metropolitan Council Report, Short-Term Water Supply, 1990 and in Working Paper No. 8, on the institutional evaluation.

The Army Corps of Engineers (ACOE) is not part of the matrix because it operates under federal law. The actions it might take with the structures it operates for the Headwaters Reservoir system would be in cooperation with, and not dictated by, the state. The developers of the matrix agreed that a series of conservation actions by downstream users must precede a request for a Headwaters release, and that it should be done only as emergency supplement.[70]

According to Minnesota Statutes Chapter 103G.285, subd. 6, all surface water appropriators are required to prepare contingency plans that spell out their response to a water supply shortage. As reported in Metropolitan Area Short-Term Water Supply Plan, most surface water users have not prepared these plans. Only Northern States Power and the St. Paul Water Utility have their own contingency plans. The city of Minneapolis is in the process of developing a contingency plan.

Instead of preparing plans, most users have signed a statement attached to the DNR permit by which they agree to abide by the DNR's decisions in the event of future water shortages. To date this requirement does not apply to ground water users. Even if not a legislated requirement, the preparation of contingency plans for water shortages by municipal, industrial and commercial users of ground water would place the Metropolitan Area in a better position to cope with droughts than they were during the droughts of 1976 and 1988.[71] Recommendations for changes in this law are made in Working Paper No. 8 on institutions.

In response to the 1988 drought, Minnesota's governor directed the formation of a drought emergency task force composed of representatives of the DNR and other agencies, including the Metropolitan Council. It has met on an "as needed" basis. The task force has not met since precipitation returned to normal levels in the spring of 1990.

WATER CONSERVATION AND CONTAMINATION

Another reason to develop contingency plans is to have a staged response in place when a water shortage develops because of contamination of the source of water, whether ground water or surface water. Because the onset of shortages caused by contamination is usually sudden, a rapid response is necessary. Advanced planning must be done for this, so that those in charge can act quickly to do such things as notify authorities, the media, the public and seek additional supplies. Waiting to develop the plan when the crisis is there often results in a poor or disordered selection of responses.[72]

The cities of New Brighton and St. Louis Park have both been faced with problems of contaminated wells in recent years. Other communities are not immune. Some aquifers are locally contaminated or have the potential for being contaminated. The city of Minneapolis, drawing all its water from the Mississippi River, is vulnerable to contamination occurring in the Mississippi River above its intakes.

BARRIERS TO WATER CONSERVATION

If water conservation is such a good idea, why is not more being done? There are some barriers to water conservation.

Historically, sales of water have generated income for the utility or the municipality operating the facility. Sometimes local improvements were financed from these water revenues. If sales are reduced, revenues will also be reduced before other benefits are realized. This problem would be overcome through the initiation of conservation pricing, wherein the price of water per unit volume increases in such demand seasons and/or in times of water shortage.

Some people believe the issue of funding or reduced revenues might be overcome as a barrier if conservation goals were fairly stated and applied to all. This would reduce the feeling that each city needed to compete with others.

Sometimes a community has postponed public education programs to reduce water usage because the funds were not readily available to finance the project. There might be long-term savings, but short-term costs came first. Rates can be increased to cover these costs, but any cost saving promised to consumers might be reduced or eliminated. This would remove an incentive for the public to cooperate in voluntary reductions.

Some water users are highly motivated to save water. Other consumers are comfortable with present habits and less inclined to change unless presented either with a crisis or an incentive to save. Regulations can be put in place, but unless there is good community acceptance, they will be difficult and expensive to enforce. In a crisis there is often good public response, but once the crisis is resolved, conservation efforts may slacken.

In the Twin Cities Metropolitan Area, abundant and inexpensive supplies of water have long been looked upon as almost unlimited. As more evidence is presented that supplies are limited, it will take time to change long-term public attitudes.

The large number of suppliers in the Twin Cities Metropolitan Area makes it more difficult, but certainly not impossible, to coordinate efforts. The possibilities for interconnections are examined in Working Paper No. 4.

Many of the present water supply systems have been in place for many years. The infrastructures are designed to meet the needs of the community. A water supplier or a community may be reluctant to alter a system that has served them well to join with others in a newly conceived system that might dictate infrastructure changes and purchase of water from outside of the community.

CONCLUSION

The intent of this study was to document the status of conservation efforts in the Twin Cities Metropolitan Area, and to identify the parties currently and potentially playing a role in conservation. Conclusions on programs to be pursued will not be presented until preparation of the long-term water plan, which will then be available for public comment.

Water conservation plans are an efficient way to respond to water shortages. Users of ground water and surface water need a different set of responses. Therefore, the local water supplier needs to develop an individual plan tailored to the communities it serves.

In the past, it was considered necessary to have regional planning only for surface water. With growing demand for water projected for this area, regional planning for ground water may also be necessary. This issue will be addressed in the long-term water supply plan being developed by the Metropolitan Council for the Twin Cities Metropolitan Area.

Water conservation can be looked upon as an alternative to new source development. Some communities have found they could postpone or avoid drilling a new well by instituting supply and/or demand management practices. The experience of Madison, Wisconsin has been cited as an example.

Some additional wells will be needed in the Metropolitan Area to handle growth. The need for some of the additional costly wells and treatment systems that accompany them might be avoided by water conservation practices.

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APPENDIX

Table A-1

TWIN CITIES METROPOLITAN AREA COMMUNITIES WATER PRICING METHODS

Increasing Block	Single Block	Flat Rate	Decreasing Block
Blaine	Andover	Belle Plaine	Apple Valley
Burnsville	Anoka	Empire Twp.	Arden Hills
Chanhassen	Bayport	Farmington	Brooklyn Park
Jordan	Bloomington	Landfall	Carver
Loretto	Brooklyn Center	White Bear Twp.	Champlin
Newport	Centerville		Chaska
Wayzata	Circle Pines		Columbia Heights
	Cologne		Cottage Grove
	Coon Rapids		Eagan
	Crystal		Excelsior
	Eden Prairie		Falcon Heights
	Edina		Forest Lake
	Elko		Fridley
	Golden Valley		Hamburg
	Hampton		Hugo
	Hastings		Lauderdale
	Hilltop		Lexington
	Hopkins		Maple Plain
	Inver Grove Hts.		Maplewood
	Lake Elmo		Mayer
	Lakeville		Mendota Heights
	Lino Lakes		Minnetrista

CITY WATER PRICING METHODS (cont.)			
Increasing Block	**Single Block**	**Flat Rate**	**Decreasing Block**
	Little Canada		New Hope
	Long Lake		New Germany
	Mahtomedi		New Trier
	Maple Grove		Norwood
	Medina		Oak Park Hts.
	Minneapolis		Osseo
	Minnetonka		Randolph
	Minnetonka Beach		Robbinsdale
	Mound		Rogers
	Mounds View		Shakopee
	New Brighton		Shorewood
	New Market		So. St. Paul
	North St. Paul		Spring Lake Pk.
	Oakdale		Spring Park
	Orono		St. Bonifacius
	Plymouth		St. Louis Park
	Prior Lake		St. Paul
	Ramsey		St. Paul Park
	Richfield		Victoria
	Rockford		Waconia
	Rosemount		West St. Paul
	Roseville		Woodbury
	Savage		Young America

CITY WATER PRICING METHODS (cont.)			
Increasing Block	**Single Block**	**Flat Rate**	**Decreasing Block**
	Shoreview		
	St. Anthony		
	St. Francis		
	Stillwater		
	Tonka Bay		
	Vadnais Heights		
	Vermillion		
	Watertown		
	White Bear Lake		
TOTAL	**TOTAL**	**TOTAL**	**TOTAL**
7	54	5	45
(6.4%)*	(49.1%)	(4.5%)	(40%)

SOURCE: List prepared by Judy Hartsoe, Associate Planner, Natural Resources Division, Metropolitan Council from the Metropolitan Council Survey.

* Percent of total

Figure 2

CITIES AND TOWNSHIPS SERVED BY MUNICIPAL SYSTEMS, 1990

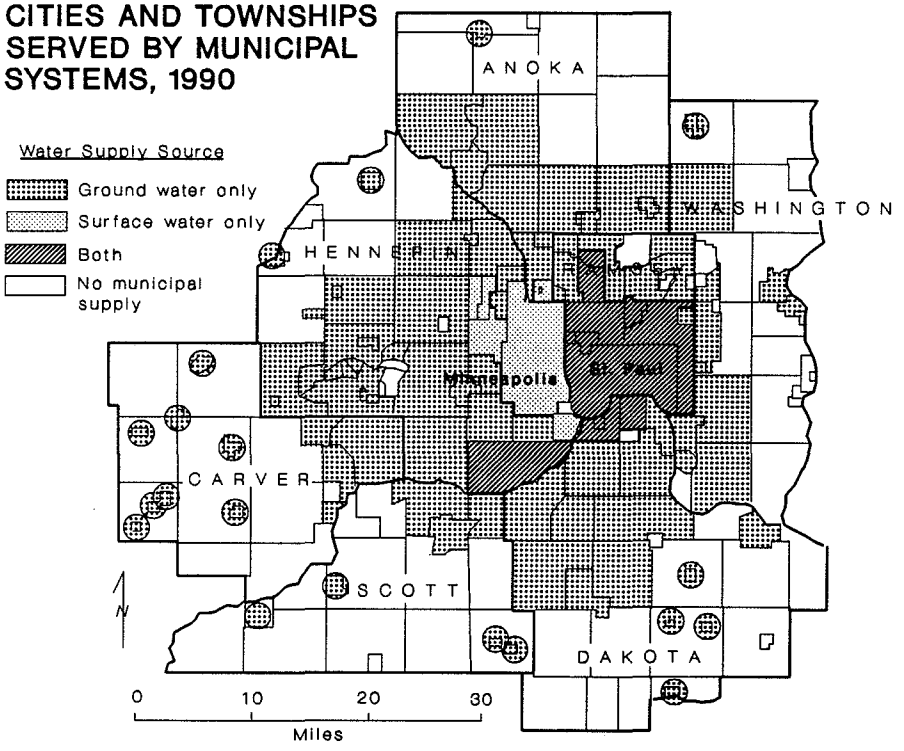

Table A-2

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA WITH MUNICIPAL SUPPLY SYSTEMS

Municipality	Population[1]	Conservation Measures Initiated	Year
ANOKA COUNTY	243,641		
Andover	15,216 (3,809)[2]	Metering Sprinkling restrictions Leak detection/repair	1981 1981-present O/E[3] 1989
Anoka	17,192 (15,950)	Metering Pricing Policy Sprinkling restrictions Commercial reuse/recycle Leak detection/repair	1928 1928 1986 O/E None indic. None indic.
Blaine	38,975 (35,560)	Metering Sprinkling restrictions	1962 1983
Centerville	1,633 (450)	Public education Metering Leak detection/repair	
Circle Pines	4,704 (4,800)	Metering Sprinkling restrictions	1960 1988
Columbia Heights	18,910 (20,000)	Buys from Mpls.--same restrictions Public education Metering Sprinkling restrictions Leak detection/repair	 1960s 1930s Mpls. 1980
Coon Rapids	52,978 (45,700)	Metering Sprinkling restrictions	1955 1987-88
Fridley	28,335 (29,423)	Metering Sprinkling restrictions Industrial reuse/recycle Commercial reuse/recycle	1960 1988 1988 1988

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA			
Municipality	**Population**	**Conservation Measures Initiated**	**Year**
ANOKA COUNTY (cont.)			
Hilltop	749 (781)	Buys from Mpls.-same restrictions Metering	
Lexington	2,279 (2,100)	Public education Metering Pressure reduction Sprinkling restrictions	1975 1965 1965 1976
Lino Lakes	8,807 (425)	Public education Metering Sprinkling restrictions Leak detection/repair	1980 1974 1988 1984
Ramsey	12,408 (500)	Metering Sprinkling restrictions	1984 1988 only
St. Francis	2,538 (800)	Public education Metering Sprinkling restrictions	1988 1975 1986 O/E
Spring Lake Park	6,532 (6,881)	Public education Metering Sprinkling restrictions Commercial reuse/recycle	1964 1964 1988-90 only 1985
CARVER COUNTY	47,915		
Carver	744 (523)	Metering	1986
Chanhassen	11,732 (10,000)	Public education Metering Pressure reduction Pricing policy Sprinkling restrictions	 1958 1973 1970 1988 O/E

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA			
Municipality	**Population**	**Conservation Measures Initiated**	**Year**
CARVER COUNTY (cont.)			
Chaska	11,339 (11,000)	Public education Metering	1990 1965
Cologne	563 (610)	Metering Pricing policy	1934 1934
Hamburg	492 (485)	Metering Sprinkling restrictions	1960 1988 only
Mayer	471 (420)	Metering	1971
New Germany	353 (370)	Metering	1960
Norwood	1,351 (1,386)	Public education Metering Sprinkling restrictions Connected with Young America	1989 1926 1988
Victoria	2,354 (150)	Metering Sprinkling restrictions	1976 1988 and '89-voluntary only
Waconia	3,498 (3,600)	Metering Sprinkling restrictions	1958 1987-89 only
Watertown	2,408 (2,200)	Metering Sprinkling restrictions	1955 1988-89 O/E
Young America	1,354 (1,300)	Metering Pricing Policy Sprinkling restrictions Connected with Norwood	1979 1987 1990

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA			
Municipality	**Population**	**Conservation Measures Initiated**	**Year**
DAKOTA COUNTY	275,227		
Apple Valley	34,598 (30,000)	Metering Pressure reduction Sprinkling restrictions Leak detection as necessary	1964 1967 1987
Burnsville	51,288 (44,353)	Public education Metering Pricing policy Sprinkling restrictions as needed	1983 1965 1965 1988 time restriction
Eagan	47,409 (42,000)	Metering Pressure reduction Pricing policy Sprinkling restrictions	1972 1970 1970 1988
Empire Twp.	1,340 (450)	Public education Sprinkling restrictions Leak detection/repair	 1985 1989
Farmington	5,940 (5,650)	Metering, considering Pricing policy, flat charge Sprinkling restrictions Leak detection/repair, as needed	1990-91 Reviewed annually 1985 O/E (total ban 4-8 p. daily) no data
Hampton	363 (390)	Metering Pressure reduction	1954 1965
Hastings	15,445	None	

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA			
Municipality	**Population**	**Conservation Measures Initiated**	**Year**
DAKOTA COUNTY, (cont.)			
Inver Grove Heights	22,477 (20,000)	Metering Pressure reduction Moderate plumbing code per normal building codes	1965 1978
Lakeville	24,854 (15,000)	Public education Metering Sprinkling restrictions	1980s 1970s 1989 only O/E
Mendota Heights	9,431 (7,811)	Buys from St. Paul Metering Sprinkling restrictions	1985,1988, 1989 only and when tank levels are low
New Trier	96	Metering	
Randolph	331 (250)	Metering	
Rosemount	8,622 (5,409)	Metering Sprinkling restrictions Leak detection/repair	1972 1995 1992
South St. Paul	20,197 (23,000)	Metering Pressure reduction in some homes Sprinkling restrictions	1930s 1989 voluntary
Vermillion	510 (500)	Metering Pricing policy	1987 1987
West St. Paul	19,248 (18,220)	Metering - St. Paul supplies, meters/ bills it Sprinkling restrictions	no data 1988-89

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA			
Municipality	**Population**	**Conservation Measures Initiated**	**Year**
HENNEPIN COUNTY	1,032,431		
Bloomington	86,335 (83,870)	Mpls. supplies parts of city Metering Pressure reduction Sprinkling restrictions	 1960 1965 & '88 1988 only
Brooklyn Park	56,381 (45,000)	Public education Metering Sprinkling restrictions Industrial reuse/recycle Commercial reuse/recycle Water saving devices	
Champlin	16,849 (15,000)	Public education Metering Sprinkling restrictions	1990 1974 1986
Crystal	23,788 (23,000)	Buys from Mpls. Metering Sprinkling restrictions	 1970 1988
Eden Prairie	39,311 (34,000)	Metering Sprinkling restrictions Retrofit of showerhead and toilets Moderate plumbing code Advanced plumbing code	1971 1979 O/E 1982 1982 1982
Edina	46,070 (46,000)	Mpls. supplies parts of city Public education Metering Sprinkling restrictions Leak detection/repair	 1987 1924 1981 O/E Ongoing

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA			
Municipality	**Population**	**Conservation Measures Initiated**	**Year**
HENNEPIN COUNTY, (cont.)			
Excelsior	2,367 (2,860)	Buys from Mpls. Metering	 1958
Golden Valley	20,971 (24,200)	Buys from Mpls. Metering	 1962
Hopkins	16,534 (16,800)	Public education Metering Sprinkling restrictions Industrial reuse/recycle Commercial reuse/recycle Leak detection/repair Low water use landscaping New and retrofit	 1987 O/E 1982 1982 1986
Long Lake	1,984 (1,900)	Public education/ voluntary conservation Metering Pressure reduction Pricing policy	1988 1948 1983
Loretto	404 (310)	Metering Sprinkling restrictions	1989 1989 O/E
Maple Grove	38,736 (36,000)	Public education Metering Pressure reduction Leak detection/repair	1981 1972 1986 1976
Maple Plain	2,005 (1,550)	Metering Sprinkling restrictions	1939 1988 only
Medina	3,096 (1,360)	Public education Metering Sprinkling restrictions	1986 1960 1987

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA			
Municipality	**Population**	**Conservation Measures Initiated**	**Year**
HENNEPIN COUNTY, (cont.)			
Minneapolis	368,383 (381,592)	Public education Metering Pressure reduction for blowing out pipes Mandatory outdoor use ban	1990 1950s 1980 1988
Minnetonka	48,370 (41,600)	Metering Pressure reduction Sprinkling restrictions	1960 1960s 1987-90 O/E, time ban
Minnetonka Beach	573 (590)	Metering Sprinkling restrictions Low-water use landscaping (new) Leak detection/repair	1932 1987 1987-88 only 1985
Minnetrista	3,439 (320)	Sprinkling restrictions Rotation sprinkling Metering	1987-89
Mound	9,634 (9,950)	Public education Metering Pricing policy Sprinkling restrictions	1989 1970s 1970 1979
New Hope	21,853 (23,500)	Buys from Mpls. None indicated except what Mpls. might impose Metering	
Orono	7,285 (2,150)	Metering Sprinkling restrictions Leak detection/repair on visual basis	1970 1987 O/E

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA			
Municipality	**Population**	**Conservation Measures Initiated**	**Year**
HENNEPIN COUNTY, (cont.)			
Osseo	2,704 (3,000)	Metering No other	1915
Plymouth	50,889 (47,000)	Sprinkling restrictions Ordinance invoked for emergency situations. Metering	
Richfield	35,710 (37,800)	Metering Industrial reuse/recycle	1962 No year ind.
Robbinsdale	14,396 (14,460)	Metering Sprinkling restrictions as needed Leak detection/repair, as needed	1950s 1990
Rockford (Pt.)	2,665 (2,800)	Sprinkling restrictions Metering	1989-90 O/E
Rogers	698 (746)	Metering Industrial reuse/recycle Commercial reuse/recycle	1960 1988 1988
St. Anthony (Pt.)	7,727 (7,981)	Buys some from St. Paul Public education Metering Pricing policy Sprinkling restrictions Leak detection/repair	 1984 1960s
St. Bonifacius	1,180 (1,070)	Metering Pricing policy Sprinkling restrictions	1971 1979 1990

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA			
Municipality	**Population**	**Conservation Measures Initiated**	**Year**
HENNEPIN COUNTY, (cont.)			
St. Louis Park	43,787 (43,463)	Public education Sprinkling restrictions Ind./commercial reuse/recycle Metering	
Shorewood	5,917 (1,356)	5 separate systems Public education when restrictions are needed Metering, some Sprinkling restrictions, if needed	1988 1988-89 O/E
Spring Park	1,571 (1,465)	Metering Retrofit of showerhead/toilet	1963 1986
Tonka Bay	1,472 (1,453)	Metering Pricing Policy Sprinkling restrictions	1974 1989 1985
Wayzata	3,806 (3,900)	Metering Sprinkling restrictions	1929 1987 O/E
RAMSEY COUNTY	485,765		
Arden Hills	9,199 (9,100)	See St. Paul Metering	
Falcon Heights	5,380 (5,386)	St. Paul supplies Metering	 1950s
Lauderdale	2,700 (2,307)	See St. Paul Metering	
Little Canada	8,971 (8,600)	Buys from St. Paul Metering	 1970s

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA			
Municipality	**Population**	**Conservation Measures Initiated**	**Year**
RAMSEY COUNTY, (cont.)			
Maplewood	30,954 (24,615)	Buys from St. Paul Metering Sprinkling restrictions Leak detection/repair	 1985 1988 1986
Mounds View	12,541 (12,550)	Public education Metering Sprinkling restrictions	1980 1964 1987
New Brighton	22,207 (23,500)	Metering Sprinkling restrictions	 1976 O/E, time ban
North St. Paul	12,376 (14,000)	Metering Sprinkling restrictions, as needed Leak detection/repair	1930s 1980 O/E Meter pumping for wells
Roseville	33,485 (35,800)	St. Paul supplies, follows their lead on restrictions. Public education Metering Sprinkling restrictions Leak detection/repair	 1988 1960s 1988 only 1986
St. Paul	272,235 (273,160)	Public education Metering Sprinkling restrictions Mandatory outdoor use ban Leak detection/repair	 1985 1988 1986 1988

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA			
Municipality	**Population**	**Conservation Measures Initiated**	**Year**
RAMSEY COUNTY, (cont.)			
Shoreview	24,587 (24,500)	Public education Metering Pricing policy Sprinkling restrictions	1991-Future 1969 1991-Future 1987-88-89 O/E only
Vadnais Heights	11,041 (6,785)	Metering Sprinkling restrictions	1978 1987
White Bear Lake	24,704 (24,000)	Public education Metering Sprinkling restrictions, nonpermanent Retrofit showerheads and toilets Moderate plumbing code Advanced. plumbing code	1988 1988 1983 O/E 1982 1985 1985
White Bear Twp.	9,424 (8,000)	Sprinkling restrictions O/E	
SCOTT COUNTY	57,846		
Belle Plaine	3,149 (3,010)	Metering Sprinkling restrictions	1988 1989 O/E
Elko	223 (150)	Public education Metering Leak detection/repair	1988 1987 1980
Jordan	2,909 (2,600)	Metering Sprinkling restrictions in drought	1940 1988
New Market	227 (310)	Metering Leak detection/repair	1930s 1992 (est)

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA			
Municipality	**Population**	**Conservation Measures Initiated**	**Year**
SCOTT COUNTY, (cont.)			
Prior Lake	11,482 (11,320)	Metering Pressure reduction Sprinkling restrictions	Pre-1970 1975 1988 O/E
Savage	9,906 (7,897)	Public Education Metering Sprinkling restrictions, ongoing Leak detection/repair, ongoing Commercial reuse/recycle	1974 1978 1988 1985
Shakopee	11,739 (10,783)	Metering Sprinkling restrictions, as needed	1930s 1988
WASHINGTON COUNTY	145,896		
Bayport	3,200 (2,000)	Metering Pricing policy Sprinkling restrictions (May-Sept.) Leak detection/repair	1930s 1988 1987 1987
Cottage Grove	22,935 (21,000)	Metering Sprinkling restrictions	1958 1982 O/E
Forest Lake	5,833 (5,400)	Public education Metering Pricing policy Sprinkling restrictions Industrial reuse/recycle Leak detection/repair	 1951 1984 1989 limited Some 1985
Hugo	4,417 (1,000)	Metering	1961

WATER CONSERVATION EFFORTS OF LOCAL UNITS OF GOVERNMENT IN THE METROPOLITAN AREA			
Municipality	**Population**	**Conservation Measures Initiated**	**Year**
WASHINGTON COUNTY, (cont.)			
Lake Elmo	5,903 (800)	Metering Pricing policy Mod. plumb. code-water save devices	1962 1982 1985
Landfall	685 (702)	None	
Mahtomedi	5,569 (4,300)	Metering Sprinkling restrictions Leak detection/repair Retrofit of showerhead/ toilets	1940 1988 1988-valve repair 1987-new homes only
Newport	3,720 (3,600)	Metering	1963
Oakdale	18,374 (16,500)	Sprinkling restrictions Metering	O/E
St. Paul Park	4,965 (4,900)	Metering Pricing Policy Sprinkling restrictions	1954 1990 1988 O/E
Stillwater	13,882 (12,770)	Metering Pressure reduction Pricing policy Sprinkling restrictions Leak detection/repair	1927 1979 1974 1988 only O/E 1978
Woodbury	20,075 (18,500)	Public education Metering Sprinkling restrictions-permanent, year round Leak detection/repair	 1956 1987 O/E 1970s

[1] SOURCE: 1990 U.S. Census (preliminary)
[2] Population Served = Updated by Metropolitan Council through October 1990
[3] O/E = Odd/Even

NOTE: Where city is in more than one county, total population is shown in county with greatest share of the population; that is, all of St. Anthony is shown under Hennepin County. Consequently, county totals may not balance.

Table A-3

WATER SAVING IDEAS BY SOURCE

DRINKING WATER

- Don't run tap water for cold water without collecting for other nonconsumptive uses.
- Make only the amount of coffee or tea you are going to drink.
- Use ice cubes to cool water.
- Recycle leftover drinking water.
- Don't let waiter bring you water unless you request it.
- Use paper cups at drinking fountains.

DRIVEWAY OR STREET

- Wash car in sections, rinse with short spurts from hose.
- Use car wash that recycles water.
- Wash car near hedges, shrubs, etc., for a free drink.

GARBAGE DISPOSAL

- Give scraps to a pet.
- Start a compost pile.
- Use recycled water with garbage disposal.
- Use garbage can more.

HOUSEHOLD CLEANING

- Use recycled water for heavy cleaning followed by a clean rinse.
- Use least possible amount of soap or cleaning agent.
- Presoak to cut down on rinse water.

KITCHEN SINK

- Use brush to clean fruits and vegetables.
- Use hand sprayer sparingly, with short bursts of water.
- Remodel with low consumption faucet aerators.
- Thaw frozen foods and ice trays in air.
- Scrape dishes with napkin from meal and rinse all dishes at once.
- Soak pots and pans.

LAWN, GARDEN

- Water slowly, thoroughly and infrequently as possible.
- Water at night or early in the morning.
- Aerate lawn, use drip irrigation systems and water timers.
- Select hardy species that don't need as much water.
- Mulch.
- Let grass grow higher in dry weather.

BACKYARD POOL

- Cover when not in use.
- Don't fill pool completely.
- Recycle wading pool for plants, shrubs, lawn.

DISHWASHER

- Preclean dishes.
- Soak pots and pans first.
- Wash only full loads.
- Use least amount of detergent.

PIPES

- Insulate hot water pipes.
- Turn faucets off when not in use.

SHOWER

- Turn off water while soaping up.
- Limit showers to 5 minutes or less.
- Use low consumption shower heads.

TOILET

- Use low consumption toilets.
- Don't flush trash.
- Repair leaks.
- Add filled bottles to tank.

FAUCET

- Repair leaks.

WASHING MACHINE

- Wash only full loads.
- Use less detergent.
- Buy a water saver machine.

UTILITY SINK

- Soak well with smallest amount of detergent.
- Save rinse water for next wash.
- Presoak very dirty items.
- Remodel with low consumption faucet aerators.

BATHROOM SINK

- Shave beard and brush teeth the water saving way.

BATHTUB

- Don't overfill bathtub.
- Don't waste initial cold water.
- Consider recycling bath water for heavy cleaning jobs.
- Shower instead.

Table 3 lists some water saving ideas which can be used by mainly by domestic users . Some of the ideas are applicable to commercial and industrial users as well.

ACRONYMS AND DEFINITIONS

ACOE	Army Corps of Engineers
ASCS	Agricultural Stabilization and Conservation Service
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
BWSR	Minnesota Board of Water and Soil Resources
DEM	Division of Emergency Management
DNR	Department of Natural Resources
DPS	Department of Public Safety
EPA	Environmental Protection Agency
EQB	Environmental Quality Board
FmHA	Farmers Home Administration
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MGD	Million gallons per day.
MGY	Million gallons per year
MGQ	Million gallons per quarter
MPCA	Minnesota Pollution Control Agency
MWCC	Metropolitan Waste Control Commission
NPDES	National Pollutant Discharge Elimination System
RIM	Reinvest in Minnesota
SCS	Soil Conservation Service
SBA	Small Business Administration
USGA	U.S. Geological Survey
WMO	Watershed Management Organization
WPB	Water Planning Board